FLUKE®

Instruction Manual

PRELIMINARY

Model

2240C

Data Logger

P/N 581348

MEMO TO BE INCLUDED IN ALL

2240C DATA LOGGERS

CONTAINING VERSION 0.3 SOFTWARE

This 2240C contains a preliminary release of control firmware. This firmware contains a few inconsistancies and therefore is only temporary. An updated version which has these inconsistencies remedied will be available on January 31.

The following is a list of these inconsistencies:

1) If the 2240C contains either a 2240C-43 or -44 Temperature option and a channel programmed with temperature linearization is currently being scanned, no front panel programming changes may be made. Programming changes must ony be done when the 2240C is in RESET.

2) If the 2240C contains either a 2240C-43 or -44 Temperature option AND a 2240C-40 Scaling option, both a temperature linearization and an mx+b scaling cannot be programmed to a channel simultaneously.

3) With a 2240C-43 or -44 Temperature option, no more than one type of temperature linearization may be programmed to channels in a scan group. However, that temperature linearization may be programmed to any number of channels within the scan group.

4) A 2240B-17 RS-232C Remote Programming or 2240B-15 IEEE Remote Programming option may only be used as an output only device (no external programming, scan format changes, or external program list may be done).

5) A program list on the internal printer will not always supply all the programmed information desired when in block programming mode. If system size is less than 255 channels, switch 4 on the controller PCB should be set to 'ON' (see 2240C Manual).

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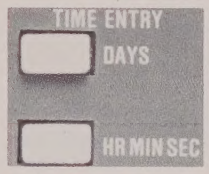
2240C PROGRAMMING GUIDE

The following is a step by step guide through 2240C front panel programming sequences and description of front panel key operations.

☐ Indicates a pushbutton to be pressed.
(XX) Indicates a pushbutton's reference number-see front panel chart at the end of this guide.
Initial Step: Press **RESET (1)** under **SCAN CONTROL**, turn key to **POWER ON**



TIME ENTRY

Days

(17) DAYS

Press **3 Digits** (Julian Date) Example: 227
(38) ENTER/STEP

Time

(18) HR MIN SEC

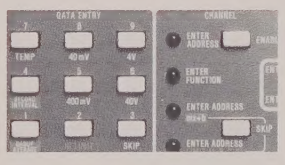
Press **6 Digits** Example: 14:21:36

(38) ENTER/STEP

CHANNEL PROGRAMMING

(Temperature Example) (Options -43 or -44 and -41)

Example:
Channel Number = 24;
Function = J Thermocouple;
Limits = 2 Hi, 1 Lo Limit



Under CHANNEL press:

(39) ENTER ADDRESS
(32) 2
(26) 4
(38) ENTER/STEP
} ENTER CHANNEL ADDRESS 24

(25) TEMP
(27) 1
(38) ENTER/STEP
} ENTER FUNCTION (J THERMOCOUPLE CODE)

mx+b skip is not required if option -40 is not installed

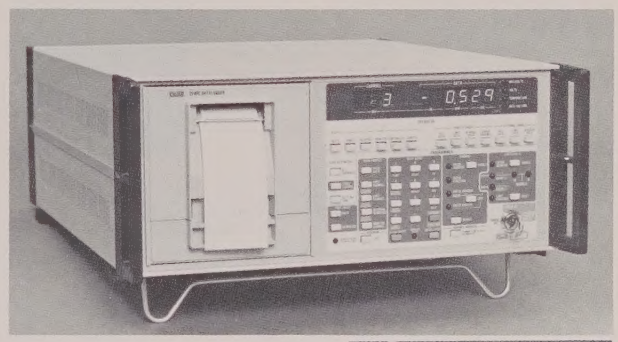
(40) SKIP
(38) ENTER/STEP
} SKIP ADDRESS mx+b

(27) 1
(38) ENTER/STEP
} ENTER LIMIT ADDRESS A

(27) 1
(35) 6
(38) ENTER/STEP
} ENTER LIMIT ADDRESS B

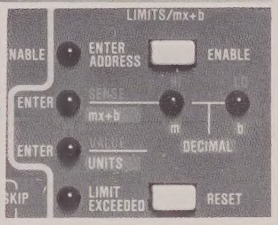
(36) 3
(27) 1
(38) ENTER/STEP
} ENTER LIMIT ADDRESS C

(40) SKIP
(38) ENTER/STEP
} SKIP LIMIT ADDRESS D



LIMITS PROGRAMMING

For Example At Left (Option -41)
First Hi Limit Address = 1 (100°)
Second Hi Limit Address = 16 (90°)
Lo Limit Address = 31 (10°)



Under LIMITS/mx + b press:

(43) ENTER ADDRESS
(27) 1
(38) ENTER/STEP
} ENTER LIMIT ADDRESS A

(32) HI LIMIT
(38) ENTER/STEP
} ENTER SENSE LIMIT A

(27) 1
(28) 0
(28) 0
(38) ENTER/STEP
} ENTER VALUE (100°) LIMIT A

(27) 1
(35) 6
(38) ENTER/STEP
} ENTER ADDRESS LIMIT B

(32) HI LIMIT
(38) ENTER/STEP
} ENTER SENSE LIMIT B

(34) 9
(28) 0
(38) ENTER/STEP
} ENTER VALUE (90°) LIMIT B

(36) 3
(27) 1
(38) ENTER/STEP
} ENTER ADDRESS LIMIT C

(33) LO LIMIT
(38) ENTER/STEP
} ENTER SENSE LIMIT C

(27) 1
(28) 0
(38) ENTER/STEP
} ENTER VALUE (10°) LIMIT C

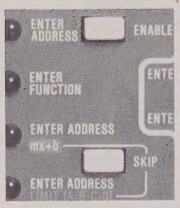
THERMOCOUPLE FUNCTION CODE

OPTION	CODE	1	2	3	4	5	6	7	8	9	10	11	12	0
-43		J	K	T	S	R	B	E	C	385	390	10Ω Cu	0-100%	REF JUN
-44		J	K	T	S	JDIN	KDIN	TDIN	SDIN	N*	385	392	0-100%	REF JUN

*Nicrosil vs Nisil

CHANNEL PROGRAMMING

(mx + b Scaling Example)



CHANNEL PROGRAMMING APPLICATION:

Pressure Transducer Input = 4 - 20 mA
Display = 100 to 200 psi
Limits = No Limits Required

Hardware Required:

Option 40 (mx + b)
Option 29 (Current Input Connector)

Programming Required:
Selected Channel = 8
Selected mx + b Address = 5
A/D Range Required = 400 mV
m calculated = 0.4167
b calculated = 7500

Under **CHANNEL** press:

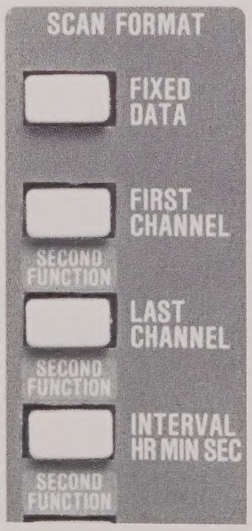
(39)	ENTER ADDRESS	ENTER CHANNEL ADDRESS 8
(30)	8	
(38)	ENTER/STEP	
(31)	400 mV	ENTER FUNCTION (A/D RANGE)
(38)	ENTER/STEP	
(31)	5	ENTER mx + b ADDRESS
(38)	ENTER/STEP	
(40)	SKIP	SKIP LIMIT ADDRESS A,B,C,D
(38)	ENTER/STEP	
(40)	SKIP	
(38)	ENTER/STEP	
(40)	SKIP	
(38)	ENTER/STEP	
(40)	SKIP	
(38)	ENTER/STEP	

PROGRAMMING PRIMARY INTERVAL:

Example:
Want to Scan Channels 50- 300
Scan Interval:
40 seconds

Under SCAN FORMAT press:

(20)	FIRST CHANNEL
(31)	5
(28)	0
(38)	ENTER/STEP
(21)	LAST CHANNEL
(36)	3
(28)	0
(28)	0
(38)	ENTER/STEP
(22)	INTERVAL HR MIN SEC
(26)	4
(28)	0
(38)	ENTER/STEP

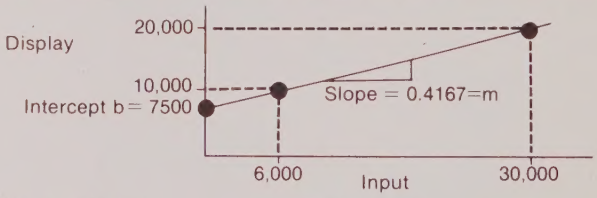


mx + b PROGRAMMING

For Example At Left (Option -40)

(37)	SECOND FUNCTION	ENTER mx + b ADDRESS
(43)	ENTER ADDRESS	
(31)	5	
(38)	ENTER/STEP	
(28)	0	ENTER Slope (m)
(26)	4	
(27)	1	
(35)	6	
(25)	7	
(38)	ENTER/STEP	
(25)	7	ENTER Intercept (b)
(31)	5	
(28)	0	
(28)	0	
(38)	ENTER/STEP	
(32)	2	ENTER DECIMAL Location (# of digits to right of decimal place.) 200 psi would read 200.00 in this case)
(38)	ENTER/STEP	
(27)	1	ENTER UNITS CODE (psi in this example)
(27)	1	
(38)	ENTER/STEP	

NOTE: 4 to 20 mA is seen by the data logger (when properly configured with Option -29 Connector) as 60 mV→300 mV (hence the selection of 400 mV as the A/D range under CHANNEL PROGRAMMING). In analog/digital converter counts, 60 mV is 6000 and 300 mV is 30,000. Desired display is chosen as 200.00 →100.00 psi. This corresponds to 20,000 and 10,000 counts, respectively.

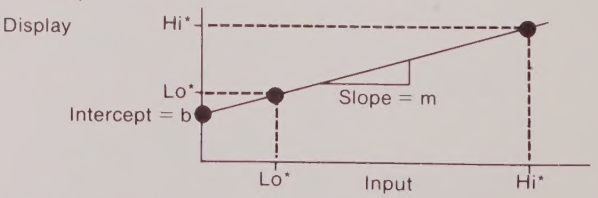


Slope Calculation: $\frac{20{,}000\text{-}10{,}000}{30{,}000\text{-}6{,}000} = 0.4167 = m$

Intercept Calculation: 10,000 - (0.4167 x 6000) =7500=b

GENERAL CASE OF COMPUTING SLOPE AND INTERCEPT

A more general set of equations for computing slope and intercept: (Note: display limited to 5 digits.)
*Values in terms of A/D counts (same as seen on display ignoring decimal.)



First Calculate:

$$\text{Slope} = m = \frac{\text{Display Hi*} - \text{Display Lo*}}{\text{Input Hi*} - \text{Input Lo*}}$$

Then Calculate: Intercept = b = Display Lo* - (m x Input Lo*)

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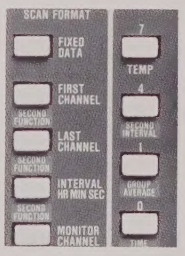
GROUP AVERAGING PROGRAMMING

Example:
Average 4 groups of 5 channels numbered 0 - 19. Recalculate these averages every minute.

(37)	SECOND FUNCTION	Establishes GROUP AVERAGE mode and sets group size=5 channels. A single 6 (simulating a "G" for GROUP AVG.) in the display indicates GROUP AVERAGE mode.
(27)	GROUP AVERAGE	
(31)	5	
(38)	ENTER/STEP	
(37)	SECOND FUNCTION	Sets First and Last Channels Encompassed in GROUP AVERAGING*
(20)	FIRST CHANNEL	
(28)	0	
(38)	ENTER/STEP	
(37)	SECOND FUNCTION	
(21)	LAST CHANNEL	
(27)	1	
(34)	9	
(38)	ENTER/STEP	
(37)	SECOND FUNCTION	Sets GROUP AVERAGE "SCAN INTERVAL" to one minute.
(22)	INTERVAL HR MIN SEC	
(27)	1	
(28)	0	
(28)	0	
(38)	ENTER/STEP	

("See SPECIAL NOTE")



*Channels contained in GROUP AVERAGE must be numbered consecutively, however, channels programmed to "*SKIP*" are ignored in the average. In this example channels 0-→4 comprise the first GROUP AVERAGE. If channels 2 and 3 are skipped, the first GROUP AVERAGE is computed only on the basis of channels 0, 1, and 4. This technique of skipping channels may be used to average groups of varying size (numbers of channels). Open thermocouples are treated as skipped channels in the GROUP AVERAGE mode.

NOTE: Limits on the Last Channel in each group become the GROUP AVERAGE limits.

SPECIAL NOTE:

The 2240C will utilize (in operation) only one of GROUP AVERAGE, TIME AVERAGE, and SECOND INTERVAL at any given time. The data logger will automatically operate utilizing the last of these three modes to be programmed. To change mode, simply press SECOND FUNCTION, followed by either GROUP AVERAGE, TIME AVERAGE, or SECOND INTERVAL, then ENTER/STEP. To interrogate the 2240C to determine its present mode, simply press SECOND FUNCTION, then FIRST CHANNEL and observe the display.
t = Time Average 6 = Group Average ttttt = Second Interval

TIME AVERAGING PROGRAMMING

Example:
Average Channels 3, 4, 5, 7, 8, 9** over 20 scans, scans performed each 30 seconds.

(37)	SECOND FUNCTION	Establish TIME AVERAGE mode and set # of scans per avg. at 20. The single "t" appearing in in the display indicates TIME AVERAGE mode.
(28)	TIME AVERAGE	
(32)	2	
(28)	0	
(38)	ENTER/STEP	
(37)	SECOND FUNCTION	Establish 1st and Last Channels in Average.
(20)	FIRST CHANNEL	
(36)	3	
(38)	ENTER/STEP	
(37)	SECOND FUNCTION	
(21)	LAST CHANNEL	
(34)	9	
(38)	ENTER/STEP	
(37)	SECOND FUNCTION	Set TIME AVERAGE Scan Interval to 30 Seconds.
(22)	INTERVAL HR MIN SEC	
(36)	3	
(28)	0	
(38)	ENTER/STEP	

(See "SPECIAL NOTE")

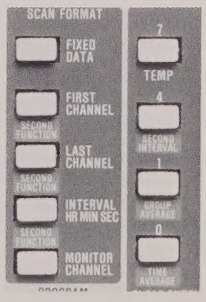
**TIME AVERAGE CHANNELS must be consecutively numbered -however, skipped channels are ignored in averaging. So in this example, Channel #6's function should be programmed as "SKIP" to exclude it from the average.

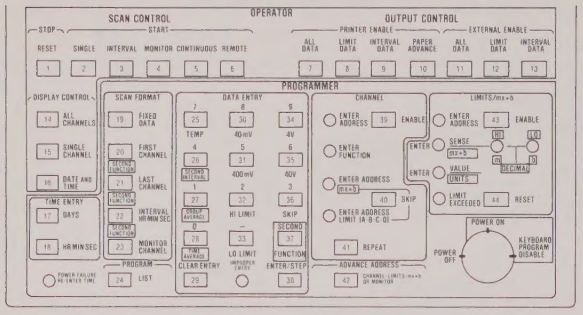
PROGRAMMING SECOND INTERVAL:

Example:
Scan on **SECOND INTERVAL** channels 0-→100
Interval: 1 hour

(37)	SECOND FUNCTION	A string of t's in the display indicates the data logger is in the SECOND INTERVAL mode.
(26)	SECOND INTERVAL	
(38)	ENTER/STEP	
(37)	SECOND FUNCTION	
(20)	FIRST CHANNEL	
(28)	0	
(38)	ENTER/STEP	
(37)	SECOND FUNCTION	
(21)	LAST CHANNEL	
(27)	1	
(28)	0	
(28)	0	
(38)	ENTER/STEP	
(37)	SECOND FUNCTION	
(22)	INTERVAL HR MIN SEC	
(27)	1	
(28)	0	
(28)	0	
(28)	0	
(28)	0	
(38)	ENTER/STEP	

(See "SPECIAL NOTE")





SCAN MODE

The following scan modes, except **MONITOR,** scan sequentially from **FIRST CHANNEL** to **LAST CHANNEL.**

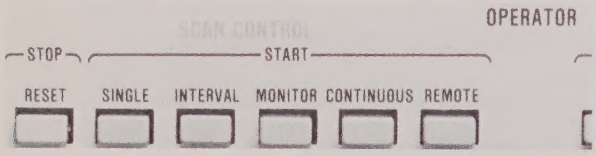
SINGLE: Initiates a single scan.

INTERVAL: Initiates a single scan immediately and repeats that scan at a programmed interval. Date and time is displayed between scans.
A delayed interval may be programmed by selecting intial interval (delay period), starting the interval, then programming a new interval (desired eventual interval) during the first interval scan. The new interval will repeat at the end of the delay period.

MONITOR: Continuously scans the programmed MONITOR CHANNEL. To program the MONITOR CHANNEL, press MONITOR CHANNEL, 3 digit channel number, and ENTER/STEP.

CONTINUOUS: Continuously repeats a scan.

REMOTE: Allows the remote start of a single scan. (At least one output option is required or Remote Control using Option -17 or -15.)



OUTPUT CONTROL

Two identical control key groups provide individual control of the PRINTER and EXTERNAL outputs. When more than one output switch is activated the sum of the functions results.

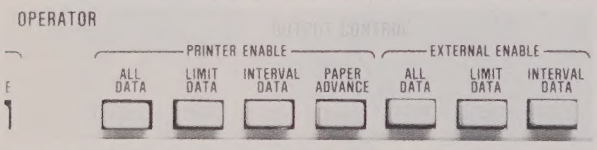
ALL DATA: All readings are recorded.

LIMIT DATA: Only that data that exceeds limits is recorded.

(Alarms once with internal switch)

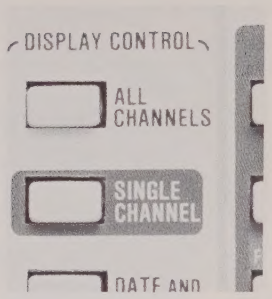
INTERVAL DATA: One scan is recorded periodically at the programmed interval. The SCAN CONTROL may be in CONTINUOUS, MONITOR, or INTERVAL mode.

The display may be used to inspect all keyboard memory (Scan Format, Time of Day and Channel and Limits programming) without affecting in any way the scan sequence in progress. To return the display to the scan sequence the **DISPLAY CONTROL** is used.



ENGINEERING UNITS NOTATION TABLE (mx+b scaling)

PROG. CODE	E/U	PROG. CODE	E/U	PROG. CODE	E/U	PROG. CODE	E/U
01	ACA	11	psi	21	ACW	31	%
02	ACmA	12	s	22	DCW	0	BLANK
03	DCA	13	ms	23	kW		
04	DCmA	14	μs	24	mW		
05	μA	15	ACV	25	μW		
06	dB	16	dBV	26	°C		
07	μF	17	DCV	27	°F		
08	Hz	18	kV	28	Ω		
09	kHz	19	mV	29	kΩ		
10	MHz	20	μV	30	MΩ		



DISPLAY CONTROL

ALL CHANNELS: Returns display to scan sequence. Displays channel number and data for each channel read.

SINGLE CHANNEL: Displays a random channel number and data for that channel without affecting the scan sequence. Updates once per scan.

A new SINGLE CHANNEL is programmed by pressing SINGLE CHANNEL, the desired channel address and ENTER/STEP. The ADDRESS button will increment SINGLE CHANNEL and then ENTER/STEP will activate the function if the Data Logger is in an appropriate scan mode.

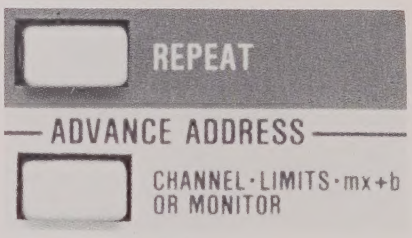
DATE AND TIME: Displays date and time continuously.

ADVANCE ADDRESS

The ADVANCE ADDRESS key may be used while programming to advance by 1 digit the channel address or the limits or mx+b address. It may also be used to advance the Monitor Channel and Single Channel number. When used in this manner it performs the functions of entering a new address one digit higher, and pressing ENTER/STEP.

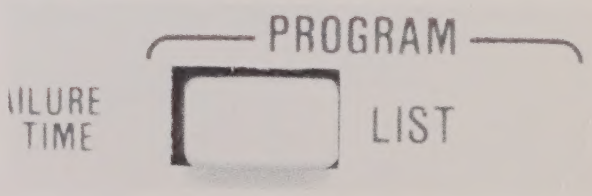
REPEAT

When programming channels the REPEAT key may be used to duplicate the function and limits address programming of the previous channel. When used with ADVANCE ADDRESS key it is not necessary to press ENTER/STEP.



PROGRAM LIST

To obtain a listing of data in memory place the Scan Control to RESET, enable the printer All DATA key (other printer enable switches must be in OFF position) and press PROGRAM LIST. The following information is listed on the printer: Time of Day, Interval, Fixed Data, Monitor Channel, all limits programming and all channel programming between First Channel and Last Channel of Primary and Secondary Intervals, Time and Group Average Data.



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2240C
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Section 1
Introduction and Specifications

1-1. INTRODUCTION

1-2. The Fluke Model 2240C Data Logger in its basic form is a processor and recorder which, through the use of optional plug-in modules, is expandable into a user-designed data acquisition system capable of servicing up to 1000 channels of guarded analog data. The basic unit is contained within a mechanical housing and consists of a front-mounted control panel, a digital display, a digital printer, a power supply, the control logic required to interface the basic unit with a full complement of options, an A/D converter and guard crossing, and a series of pcb and module slots designed to accommodate a number of plug-in options. To form an operational data acquisition system, the 2240C must be equipped with at least one each of the two following options: a scanner (Option -05 or -06) and a scanner input connector (Option -07 or -08).

1-3. The front panel of the 2240C features all of the controls necessary to operate the unit with a full complement of optional plug-ins. The controls consist primarily of pushbutton switches which are separated into 10 unique groups. Five groups perform control functions and five groups are dedicated to programming the 2240C. The control group includes: Power, OUTPUT CONTROL, PROGRAM LIST, SCAN CONTROL, and DISPLAY CONTROL. The program groups include: TIME ENTRY, SCAN FORMAT, PROGRAMMING (CHANNEL, AVERAGING, mx + b, and LIMITS), ADVANCE ADDRESS, and DATA ENTRY.

1-4. The 2240C is energized when the power switch is set to POWER ON or KEYBOARD PROGRAM DISABLE. In the POWER ON position, all control functions are enabled. In KEYBOARD PROGRAM DISABLE, all control functions except OUTPUT CONTROL and SCAN CONTROL are enabled. If channel programming data has been previously entered into memory (via the front panel programming switches), any one of four unique scan modes (single, interval, monitor, or continuous) can be started and/or stopped using the SCAN CONTROL switches. During a scan sequence, analog data present at program-selected channels is measured and displayed at the 2240C front panel. When desired, this measurement data can also be recorded on either the internal printer and/or an external recording device. The recording devices to be used and the type of data to be recorded are selected by the OUTPUT CONTROL and the SCAN CONTROL switch groups. While measurement data is being recorded, alternate forms of data (date and time or single channels) can be selected and displayed by depressing the appropriate switches in the DISPLAY CONTROL group. Similarly, an alternate form of data, program list, can be recorded when the SCAN CONTROL switches are reset and the internal printer is enabled to print all data. When the PROGRAM LIST switch is depressed under these conditions, the contents of the keyboard controlled program memory are recorded on the internal printer.

If a Remote Program Option (-15 or -17) is installed, a program list can be requested and output via the option.

1-5. The programming switch groups are enabled when the POWER switch is set to POWER ON. Program data is manually entered via the DATA ENTRY keyboard and the specific kind of data to be entered is determined by selecting it from either the TIME ENTRY, SCAN FORMAT, or PROGRAMMING (CHANNEL, AVERAGING, mx + b and LIMITS) switch groups. Time is entered in days, hours, minutes, and seconds, and is easily synchronized to the true time-of-day. The scan format can be randomly programmed to define: 6 digits of fixed data, first and last channel in a scan sequence, time interval between the start of scan sequences when the interval scan control mode is initiated, and the single channel to be monitored when the monitor scan control mode is initiated. Channel programming switches enable unique measurement functions and measurement limits to be assigned to each channel in the scan format. If one or more channels in the scan format are not to be used, a skip function can be programmed. Limits programming (Option -41) switches enable up to 60 unique 5-digit limit values (including HI/LO sense and polarity) to be programmed. Each limit is assigned a unique address code from 1 to 60, and any one of the limit values assigned to codes 1 through 15, 16 through 30, 31 through 45, and/or 46 through 60 can be assigned to any channel by entering the appropriate address codes while programming channel data.

1-6. In addition, 30 user-programmable math scaling functions are available with Option 2240C-40 installed. The scaling functions use the formula mx + b, and engineering units notation is also programmable. The Data Averaging Option (2240C-42) provides single-channel time averaging and multi-channel group averaging. Up o 30 individual channels may be averaged over a selectable period from 2 to 99 readings. Also, up to 30 groups of channels may be averaged, with a maximum of 99 channels per group. A second averaging interval may be programmed by pressing the SECOND FUNCTION switch, then selecting the second interval.

1-7. The digital display is functionally two separate displays which are used for visually presenting the current measurement channel (three digits) and the current measurement data for that channel (polarity, plus five digits and a decimal point). During a normal scan sequence (first channel to last channel), the measurement channel is incrementally advanced as each channel measurement is completed, and continues to advance after each measurement until the last selected channel, (000 up to 999) is scanned. A series of annunciators complement the display and indicate the selected measurement function (volts, millivolts, or temperature) for the channel indicated. The display is also used during the scan intervals to present the current date and time, and during programming sequences to display program data.

1-8. The printer employed in the 2240C is the Seiko Model

102. It is medium speed ink impression line printer, capable of recording data at a maximum rate of 2.5 lines per second. Sixteen data columns are available. However, the print format for a scan sequence is fixed, as described in Section 2. Ordinary 2-1/4 inch fan-fold adding machine paper is used as the recording medium . A front-panel drawer is provided for both housing and take up of the self-stacking fan-fold paper.

1-9. The power supply provided with the 2240C is capable of servicing both the basic unit and a full complement of options. Input power requirements are 100, 115, or 230V ac +10%, 50 to 60 Hz, 50 watts maximum. The desired combination of line voltage and frequency should be specified at the time of purchase.

1-10. The control logic of the 2240C includes all of the circuitry necessary to accommodate a full complement of 2240C options. Two important features of the control logic are the program memory and the guard crossing. The program memory is impervious to the line power interruption and can be maintained for several years after the 2240C is switched off. The memory is sustained by a lithium battery which is switched into operation when the line power is removed. The guard-crossing circuit electrically isolates the operation of the scanner blocks (Option -05 or -06) and the analog portion of the measurement circuit (A/D Converter) from the digital control and external equipment interface section of the 2240C.

1-11. The A/D Converter and Guard Crossing pcbs operate in conjunction to form a programmable, four-range (40 mV, 400 mV, 4V, and 40V), dual-slope A/D Converter. All four ranges can be programmed via the Guard Crossing, and include a 40,000 count full-scale output capability. As a result, 1 uV can be accurately resolved on the 40 mV range.

1-12. Several options and accessories are available for use with the 2240C. The options, their quantity limitations and their installation requirements (factory or field) are listed in Table 1-1. Table 1-2 provides a description of the sub-options included in -12, -13, -14, -15 and -17 series of options, and Table 1-3 describes the available 2240C accessories. Descriptions of the options and accessories (all except 2201A, 2202A, and 2203A) are included in Section 6 of this manual. The 2201A, 2202A, and 2203A series of scanner chassis are documented in separate stand-alone instruction manuals.

1-13. SPECIFICATIONS

1-14. Specifications for the Model 2240C Data Logger are contained in Table 1-4. Specifications for the options are supplied in the appropriate option subsection in Section 6, Options and Accessories.

Table 1-1. 2240C Option Information

FUNCTION	OPTION NO.	DESCRIPTION	QUANTITY USED MAX	QUANTITY USED MIN	CUSTOMER INSTALLED?
Input Connectors	-03	RTD Connector	6	1	Yes
	-07	Solder Pin Connector			
	-08	Isothermal Block Connector			
	-28	Current Transmitter 1-5 mA			
	-29	Current Transmitter 0-20 mA			
	-30	Current Transmitter 10-50 mA			
Scanners	-05	General Purpose Scanner	6	1	Yes
	-06	Low Level Scanner			
	-33	Eight Channel RTD Scanner			
Linearization	-43	Temperature	1	0	Yes
	-44	Measurement	1	0	Yes
Alarms	-41	Limits Option	1	0	No
	-23	Alarm Set Point Output	2	0	Yes
Digital Input	-16	Digital Input Interface			
Digital I/O	-15	Remote Programming			
	-17	Interface			
Digital Output	-12	TTY RS-232-C	3	0	Yes
	-13	Paper Punch/Cassette Interface	3	0	Yes
	-14	Magnetic Tape Interface	3	0	Yes
Second Interval	-32	Dual Interval	1	0	Yes
Scaling	-40	mx + b Scaling and Engineering Units	1	0	No
Averaging	-42	Data Averaging	1	0	No

NOTE:
These options are subject to change. Please consult a Fluke Sales Representative for an up to date listing.

Table 1-2. Description of –12, –13 and –14 Series Options

OPTION NO.	DESCRIPTION	RECORDER TYPE	OPTION CONFIGURATION		
			RECORDER	CABLE	INTERFACE
12B	ASR33 Interface	Teleprinter	•	•	•
12C	T1733 KSR RO Interface		•	•	•
12L	RS-232C Data Terminal Interface		•	•	•
12M	RS-232C Modum Interface	Modum	•	•	•
12N	Tektronix 4923 and Interface	Cartridge, Mag Tape	•	•	•
13A	Facit 4070 (benchtop) and Interface	Paper Tape	•	•	•
13B	Facit 4070 (rackmount) and Interface	Punch	•	•	•
13C	Facit 4070 Interface		•	•	•
13D	Facit 4203 0005 and Interface	Cassette	•	•	•
13E	Facit 4203 0005 Interface		•	•	•
14A	Kennedy 1600/5 and Interface		•	•	•
14B	Kennedy 1610/5 and Interface		•	•	•
14C	Kennedy 1600/360 and Interface		•	•	•
14D	Kennedy 1610/360 and Interface	Magnetic Tape	•	•	•
14E	Kennedy 1600/5 or 1610/5 Interface		•	•	•
14G	Kennedy 1600/360 or 1610/360 Interface		•	•	•
14J	Kennedy 9853-9 and Interface		•	•	•
14K	Kennedy 9852-9 Interface			•	•
15	IEEE Interface				•
17A	Data Communication Interface			•	•
17B	Data Terminal Interface			•	•
17C	Current Loop (20mA) Interface	Remote Programming		•	•
17G	Remote Interface PCB				•
17J	Columbia 300c Reader and Interface-115 Vac		•	•	•
17K	Columbia 300c Reader and Interface-100, 115, or 230 Vac		•	•	•

Table 1-3. 2240C Accessories

MODEL NO.	DESCRIPTION	FUNCTION
2201A	Scanner Chassis	Houses up to twelve -05 or -06 scanners; operates up to 50 ft. from 2240C.
2202A	Remote Scanner Chassis	Houses up to ten -05 or -06 scanners; operates up to 1500 ft. from 2240C.
2203A	RTD Scanner Chassis	Houses up to -04, -05, or -06 scanners; operates up to 1500 ft. from 2240C.
2200A-7007	Interface Connector, Blank	I/O connector for use with option -16 or -17.
2200-7006	General Purpose Interface Cable (6-foot)	I/O connector and cable for use with option -16 or -23.
2200-7005	Service Extender Cable Set	Extends most 2240C PCBs for servicing.
M07-205-600	Rack Mounting Kit	Rack-mounts 2240C in 19" wide console.
M00-280-610	Rack Slide Kit, 24" Cabinet	Slide-mounts 2240C in 19" wide X 24" deep cabinet.
2010A-7013	Fan-Fold Printer Paper (1 dozen)	Replacement printer paper.
2010A-7014	Printer Ribbon (1 dozen)	Replacement printer ribbon.

TABLE 1-4. 2240C Specifications

OPERATIONAL SPECIFICATIONS	
Channel Capacity	60 channels, expandable to 1000 channels using 2201A, 2202A, and/or 2203A Scanner Chassis
System Speed (Channels/Sec)	Refer to Table 1-5 for both 50 and 60 Hz system speeds.
Channel Display	3 digits
Data Display	
Numeric	Polarity plus 5 digits
Annunciator	mV, V, temperature, date and time
Scan Controls	Push button switches initiate the following sequences: SINGLE — CONTINUOUS INTERVAL — REMOTE MONITOR — STOP/RESET
Output Controls	Push button switches control internal printer and/or external recorder operation. PRINTER ENABLE — EXTERNAL ENABLE ALL DATA — ALL DATA ALARM DATA — ALARM DATA INTERVAL DATA — INTERVAL DATA PAPER ADVANCE
Display Control	Push button switches select one of the following functions for display: ALL CHANNELS — DATE AND TIME SINGLE CHANNEL
Time Entry	Push button switches enable keyboard entry of 3-digit date (day) or time (HR,MIN,SEC). Clock operates from 50 or 60 Hz line frequency.
Scan Format	Push button switches enable keyboard entry of the following scan information: FIXED DATA — INTERVAL-HR,MIN,SEC

1st CHANNEL MONITOR CHANNEL
LAST CHANNEL 2nd INTERVAL-HR,MIN
1st CHANNEL, SECOND INTERVAL
LAST CHANNEL, SECOND INTERVAL

Program List.....Push button switch enables printer to record contents of program memory. This includes: channel number, range and function, limits address, limits value, fixed data, monitor channel, time of year, first interval, second interval, mx+b address and values, and averaging mode.

Programming.....Push button switches enable keyboard entry of unique program data for each of the channels. This includes:

CHANNEL
- Address.....000-999
- Function.....40 mV, 400 mV, 4V, 40V, T1-T12, and Skip
- Address Limit A...1 through 15
- Address Limit B...16 through 30
- Address Limit C...31 through 45
- Address Limit D...46 through 60

LIMITS
- Address.....1 through 60
- Sense.....High or Low
- Polarity.....+ or -
- Value.....-39990 to +39990

MX+B
- Address.....1 through 30
- m.....-39990 to +39990
- b.....-99999 to +99999
- Decimal Point location.....0 (xxxxx)
  1 (xxxx.x)
  2 (xxx.xx)
  3 (xx.xxx)
  4 (x.xxxx)
- Engineering Units.....See Table 1-5

Advance Address.....Push button switch for step

	advancing channel, alarm, mx+b, monitor channel, or single channel address.
Digital Printer	
Print Speed.....	2.5 lines/sec.
Print Mechanism.....	Seiko Model 102
Column Capacity.....	16
Program Memory.....	Non-volatile with minimum life of 5 years (program data is retained while power is off.
Options Required for Operation.....	Minimum of one Scanner PCB (Option -05 or -06) and one input connector (Option -07 or -08).
A/D Converter	
Compatibility.....	Specifications apply when used with Low Level Scanner option (Option -06).
Measurement Method...	Dual slope integration over 5 line cycles (slow speed), or 1 line cycle (fast speed).
Measurement Speed....	3 readings/second with integration over 5 line cycles (slow speed), or 15 readings/second with integration over 1 line cycle (fast speed).
Dynamic Range.....	± 40,000 counts (0-39,000).
Ranges.....	± 40 mV (1 uV resolution). ± 400 mV (10 uV resolution). ± 4V (100 uV resolution). ± 40V (1 mV resolution).
Input Impedance.....	>200M on all ranges except 40V range: input impedance is 10M on 40V range. The A/D Converter uses a single-pole R-C input filter. Its input impedance is initially 39k , and increases to ≥ 200M when the filter is settled (fully charged). Since settling time is not an operator controlled function, the source impedance of the circuit being measured must be <4k to achieve

	the full 200M input impedance, and thus, avoid filter settling errors. See Figure . Refer to the A/D Converter theory of operation for additional details.
Zero Stability.....	Automatic zero
Overload without Damage.....	170V dc or peak ac any range
Overrange Indication.....	Front panel display, printer and output indicate overrange
Common Mode Rejection.....	140 dB at 50 and 60 Hz ± 0.1%. 120 dB at dc with 1k unbalance at slow speed. 110 dB at 50 and 60 Hz ± 0.1%, 120 dB at dc with 1K unbalance at fast speed.
Common Mode Voltage..	Maximum of 350V dc or peak ac.
Normal Mode Rejection.....	70 dB at 50 and 60 Hz ± 0.1% slow speed. 55 dB at 50 and 60 Hz ± 0.1% fast speed.
Accuracy (system)	
90 days (20-30 C)....	± (0.01% reading +0.005% range +1 uV) slow speed. ± (0.01% reading +0.008% range +2 uV) fast speed.
1 Year (15-35 C).....	± (0.02% reading +0.01% range +2uV) slow speed. ± 0.02% reading +0.015% range +4 uV) fast speed.
Temperature Coefficient..... (0-20 C and 30-50 C)	± (0.001% reading +0.001% range) per degree C.
Reference Voltage For Self Check.....	Available via 2 jacks at the rear of the instrument.
Reference Voltages...	2V, 0.02V
Reference Accuracy...	90 days, 20 C-30 C
Reference Stability..	± 0.003%/ C ± 0.003%/year

GENERAL SPECIFICATIONS

Dimensions.....7 in. H X 17 in. W X 22.47 in. D

	(17.78 cm X 43.18 cm X 57 cm) Refer to Figure 1-1.
Weight.....	Approx. 40 Pounds (18.144 kg) without options.
Power.....	Specifiy one of the following combinations at time of purchase: 100V ac ± 10%, 50 Hz 115/230V ac ± 10%, 50 Hz 100V ac ± 10%, 60 Hz 115/230V ac ± 10%, 60 Hz
Warm-up Time.....	One hour for full accuracy. Accuracy is reduced by 0.02% of range at initial power-up.

ENVIRONMENTAL SPECIFICATIONS

Temperature	
Operating.....	0 C to +50 C
Storage.....	-40 C to +60 C
Humidity.....	80% relative, non-condensing, 0 to +35 C. 70% relative, non-condensing, +35 to +50 C
Shock & Vibration.....	Meets MIL-T-28800A, Class 4

Table 1-5. System Speed (Channels/Seconds)

SCAN CONTROL MODE	A/D SPEED	ENABLED OUTPUT DEVICE									
		INTERNAL PRINTER		−14 (4800 BAUD)		−12 (110 BAUD)		−13		−17 (4800 BAUD)	
		VOLTS	TEMP.	VOLTS	TEMP.	VOLTS	TEMP.	VOLTS	TEMP.	VOLTS	TEMP.
Monitor	Fast	2.65	2.65	14.8 (12.3)	13.0 (12.1)	0.65	0.65	4.6	4.6	14.8 (12.3)	12.3 (11.5)
	Slow	2.65 (2.46)	2.65 (2.32)	2.96 (2.46)	2.78 (2.32)	0.65	0.65	2.96 (2.46)	2.78 (2.32)	2.96 (2.46)	2.78 (2.32)
Continuous or Interval	Fast	2.65	2.65	14.7 (12.3)	11.4 (11.0)	0.65	0.65	4.6	4.6	14.7 (12.3)	11.0 (10.7)
	Slow	2.65 (2.46)	2.65 (2.23)	2.96 (2.46)	2.69 (2.23)	0.65	0.65	2.96 (2.46)	2.69 (2.23)	2.96 (2.46)	2.68 (2.23)

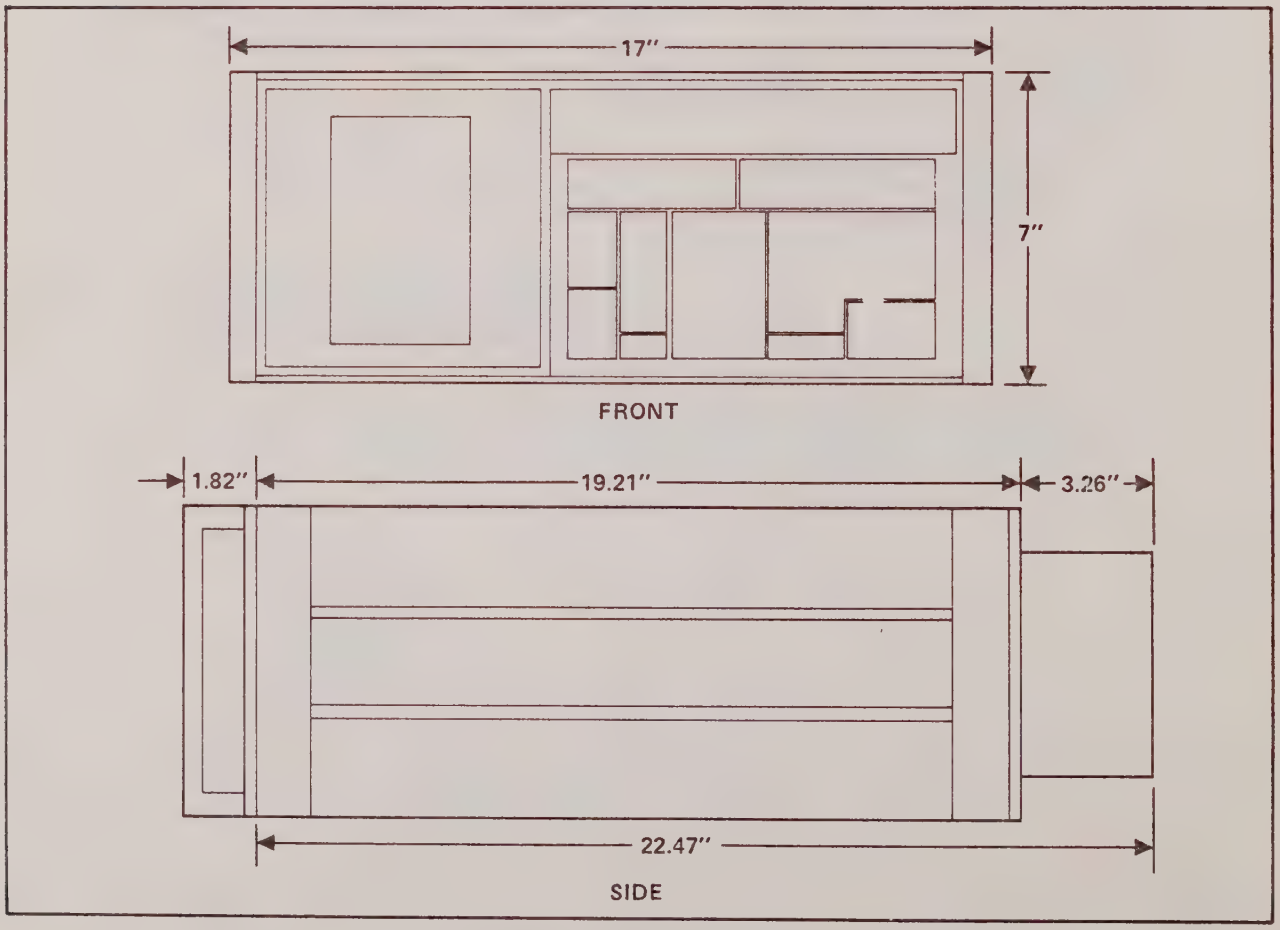


Figure 1-1. Outline Drawing

Section 2
Operating Instructions

2-1. INTRODUCTION

2-2. This section of the manual contains information concerning the installation and operation of the Model 2240C Data Logger. It is recommended that the contents of this section be read and understood before any attempt is made to operate the instrument. Should any difficulties arise during operation, contact your nearest John Fluke Sales Representative, or the John Fluke Mfg. Co., Inc., P.O. Box 43210, Mountlake Terrace, WA 98043; telephone (206) 774-2211. A list of sales representatives is given in Section 7.

2-3. SHIPPING INFORMATION

2-4. The 2240C is packaged and shipped in a foam-packed container. Upon receipt of the instrument, a thorough inspection should be made to reveal any possible shipping damage. Special instructions for inspection and claims are included in the shipping carton.

2-5. If reshipment of the instrument is necessary, the original container should be used. If the original container is not available, a new container can be obtained from the John Fluke Mfg. Co., Inc. Please reference the instrument's model number when requesting a new shipping container.

2-6. INPUT POWER

2-7. The 2240C can be operated from either 100, 115, or 230V ac, 50 or 60 Hz line power, depending upon the combination specified at the time of purchase. Check the rear panel decal for the voltage and frequency selected prior to shipment. If a change in either is required, refer to Section 4 of the manual for the proper selection procedures.

2-8. RACK INSTALLATION

2-9. The 2240C is designed for either bench-top use or for installation in a standard 19-inch equipment rack using the accessory Rack Mounting Kit (John Fluke P/N M07-205-600). Chassis slides (John Fluke P/N M00-208-610) can also be installed to facilitate access to the instrument when it is installed in an equipment rack. Information regarding the installation of the rack-mounting accessories is included in Section 6.

2-10. OPERATING FEATURES

2-11. The function and location of all 2240C controls and indicators is shown is Figure 2-1 and described in Table 2-1.

2-12. OPERATING NOTES

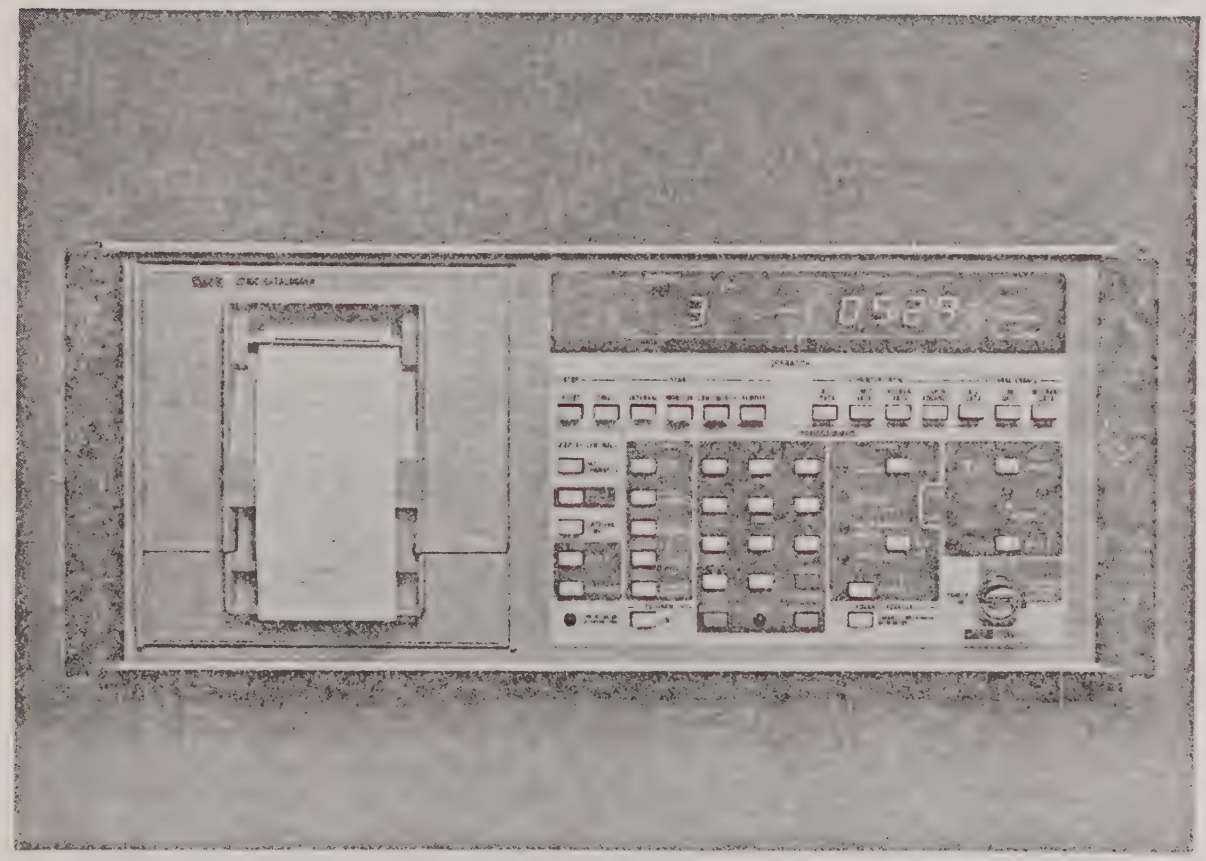


Figure 2-1. 2240C Front Panel Controls and Indicators

Table 2-1. 2240C Front Panel Controls and Indicators

REF. NO.	NAME	FUNCTION
1	CHANNEL/DAY	A three-digit, multi-purpose display which provides any one of the following read-outs: CHANNEL, DAY, or limits address. CHANNEL data is displayed as a three-digit number from 000 to 999. DAY data is displayed as a three-digit date code from 000 to 999, and can be distinguished from CHANNEL data by a lit DATE AND TIME lamp in the display annunciator group. Limits address data is displayed as a two-digit code from 01 to 60. The left-most digit is blanked to distinguished it from both Channel and Day data.
2	DATA/HR:MIN:SEC Display	Six-digit display if any if the following: measurement data (voltage, temperature, ect.); time-of-day in hours, minutes, and seconds; programmed function; programmed limit value; programmed mx + b function; or Average mode and data.
3	Display Annunciator	Four LEDs which lite on a mutually-exclusive basis to indicate the kind of data currently present on the CHANNEL/DATA display, or the limits group selected during programming.
4	OUTPUT CONTROL Switches	Seven push button switches, in two groups (EXTERNAL ENABLE and PRINTER ENABLE), that provide individual control over the type of data to be recorded on the printer and any external recording peripherals. Three switches in each group select ALL DATA, ALARM DATA, INTERVAL DATA, or all of these. A fourth switch (PAPER ADVANCE) in the PRINTER ENABLE group manually advances the printer paper.
5	PROGRAMMING Switches	Three groups of push button switches (CHANNEL, LIMITS and mx + b) allow function, limit and scaling data to be assigned to each channel. Data is entered through the DATA ENTRY keyboard, and a program sequence for channel, limits or scaling is initiated by pressing the ENABLE switch in the appropriate group. A lamp is lit to prompt data entry. When data entry is completed, press the ENTER/STEP switch in the DATA ENTRY switch group to advance the sequence.
6	SECOND FUNCTION Switch	A push button switch that allows entry of a second set of limits, for each channel, a second interval, a second averaging function, or mx + b scaling.
7	Power Switch	A three-position, key-operated switch controls 2240C power. In either the POWER ON or the KEYBOARD PROGRAM DISABLE position, the 2240C is operational. However, program data can be entered only with the switch in the POWER ON position. Removing the key with switch in the KEYBOARD PROGRAM DISABLE position prevents tampering with, or accidental destruction of, program data.
8	ADVANCE ADDRESS Switch	A push button switch that sequentially advances the displayed channel, limits address, or mx + b address. It also advances the monitor channel address (when either mode is selected) to allow manual scanning of channels and the single channel address.
9	DATA ENTRY Keyboard	A general purpose, push button keyboard for entering variable program data. It works with the TIME ENTRY, SCAN FORMAT and PROGRAMMING switch groups. CLEAR ENTRY, ENTER/STEP and SECOND FUNCTION switches are also provided. An IMPROPER ENTRY, lamp lights is an attempt to enter illegal data has been made.
10	SCAN FORMAT Switches	A series of push button switches that enable programming a scan format sequence through the DATA ENTRY keyboard. A fixed data heading, first and last channels, and first and second time intervals may be entered in the interval scan mode. In the monitor scan control mode, the MONITOR CHANNEL switch allows the monitored channel to be assigned through the keyboard.

Table 2-1. 2240C Front Panel Controls and Indicators (cont)

REF. NO.	NAME	FUNCTION
11	PROGRAM LIST Switch	A push button switch which initiates a printout of all limits data and the first channel through last channel data in program memory. The RESET switch (in the SCAN CONTROL group) and the ALL DATA switch (in the PRINTER ENABLE group) must be pressed before pressing the PROGRAM LIST switch. See Figure 2-8 for an example of data listed.
12	TIME ENTRY Switch	Push button switches that allow the date and time to be set via the DATA ENTRY keyboard. Seperate switches provide for entry of either the three-digit time-of-day. A power failure lamp included in this group indicates an interruption of power since the time was set.
13	DISPLAY CONTROL Switches	Push button switches that provide manual selection of displayed data during a scan sequence. The switches will not interrupt the scan sequence or the recorded data. ALL CHANNELS: Selects all channels in a scan sequence for display. In INTERVAL SCAN mode, the day-of-year (3 digits) and time-of-day (6 digits) are displayed between scans. SINGLE CHANNEL: Allows a single channel to be addressed through the Data Entry Keyboard. The single channel is selected for display when ENTER/STEP is pressed. This procedure does not alter the scan sequence. DATE & TIME: Selects the date and time for display.
14	SCAN CONTROL Switches	Six, mutually-exclusive, push button switches which select a scan control mode. STOP/RESET: Terminates any previously selected scan control sequence. SINGLE: Initiates the SINGLE scan control mode; i.e., one scan sequence is executed. INTERVAL: A scan sequence is initiated at programmed time intervals (primary and secondary). MONITOR: Initiates a continuously repeated scan of monitor channel. CONTINUOUS: Initiates a continuously repeated, sequential scan of all channels. REMOTE: In conjunction with any output option (12, 13, 14), it provides remote start of a scan sequence. If Option 15 or 17 is installed, it enables full remote programming of the 2240C.

2-13. The following paragraphs describe various conditions which should be considered before operating the 2240C.

2-14. AC Line Connection

2-15. The rear-panel, three-prong, U-ground connector permits the 2240C to be connected, through a power cord, to either 100, 115, or 230V ac, 50 to 60 Hz line power. The offset prong on this connector is connected to the 2240C chassis and should be connected, via the power cord, to a high quality earth ground.

2-16. Printer Paper Installation

2-17. Standard 2-1/4-inch fan-fold adding machine tape is used as a recording medium for the printer. A package of fan-fold paper is shipped with the 2240C and should be installed before attempting to operate the unit. Use the following procedure for installing the printer paper:

NOTE

The printer is not designed to accommodate rolled paper tape.

1. Fully extend the tape drawer, raise the panel above the drawer to a horizontal position, and pull the paper cutter bar away from the print drum.

2. Pick up the paper pack so that the red marking (visible on one side of the package) is located on the bottom of the stack (some packs may not have the red marking).

3. Remove the band from the paper and fold out the top sheet. This provides a leader for loading the tape into the printer mechanism.

4. Hold the pack with the leader pointing on top and away from the printer. Then slide the pack deep into the tape drawer. When properly positioned, the front of the pack should be just behind the front panel.

5. Turn on the printer, using the procedure given later in this section under Operation.

6. Locate the arrow on the front of the printer mechanism. The arrow points to the paperfeed slot. Hold the paper leader in a horizontal position and insert it as far as possible into the feed slot (5/8 of an inch). Depress and hold the PAPER ADVANCE switch until 8 to 10 inches of leader has been fed through the printer mechanism.

7. Thread the leader through the paper cutter bar and press the bar back into position.

8. Thread the leader through the front panel opening and close the panel. Check to ensure that the paper is still free to advance.

9. The tape drawer should be left in the extended position, and used to store the printed tape expelled from the printer. Guide the first two or three folds into position in the drawer.

NOTE

Simplified paper loading instructions are given on a decal located in the bottom of the paper drawer.

2-18. Printer Ribbon Installation

2-19. A printer ribbon is supplied with the 2240C and should be installed before attempting to operate the instrument. The ribbon installation location is accessible by raising the printer's front panel to the horizontal position. If the ribbon is already installed, refer to Figure 2-2 and check to ensure that the ribbon is properly positioned on the feed guides and that the ribbon spools are threaded in the proper direction. Use the following procedure for ribbon installation:

1. Separate the ribbon spools and lay them on a flat surface with their finger-side down.

2. Refer to Figure 2-3 and ensure that the ribbon is properly threaded on the spools.

3. On the printer mechanism, locate and push down the detecting lever of either spool shaft (see Figure 2-2) and with the finger-side of either spool pointer toward the printer mechanism, slide one of the spools onto the shaft.

4. Unwind 6 or 8 inches of ribbon from the remaining spool, if necessary, and position the ribbon over the feed guides as shown in Figure 2-2.

5. Depress the detecting lever on the empty spool shaft and slip the second spool onto the shaft. Make sure there are no twists in the ribbon.

2-20. Option Information

2-21. The front panel operating instructions, given in this

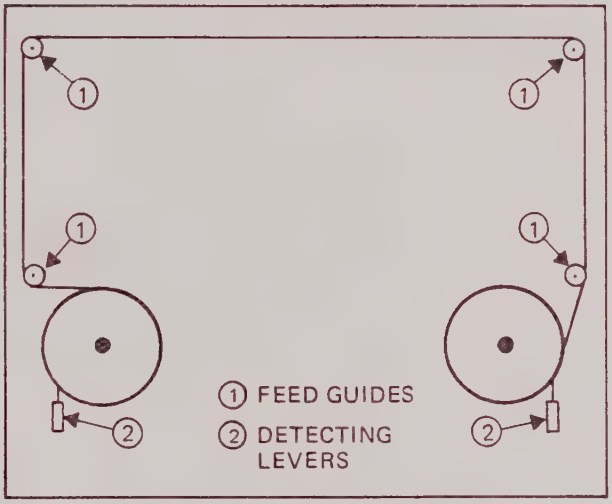


Figure 2-2. Properly Installed Ribbon

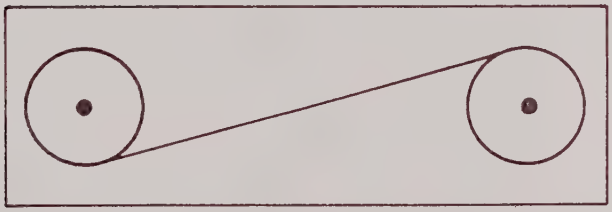


Figure 2-3. Threading Direction for Ribbon Spools

section of the manual, assume that the 2240C contains a full complement of options as shown in Figure 2-4. However, information which is unique to a particular option, such as, description, installation, interface information, maintenance, etc. is contained in the appropriate subsection of Section 6, Option and Accessory Information.

2-22. Scanner Extension

2-23. The channel scanning capability of the 2240C can be extended from 60 possible channels up to 1000 channels. The extension is accomplished through the use of one or more of the Model 2201A/2202A/2203A Scanner Chassis which are available as accessories. The units interconnect in a daisy-chain fashion, and the first unit in the chain connects to a rear-panel connector on the A/D Converter PCB (location B in Figure 2-4).

2-24. Each scanner chassis is capable of housing and controlling either 10 (2202A or 2203A) or 12 (2201A) scanner blocks. Since each block contains 10 channels, a total of 100/120 channels can be added with each scanner chassis included in the daisy-chain. The 2201A, 2202A, and 2203A Scanner Chassis are documented in separate stand-alone instruction manuals.

2-25. Internal Switch Settings

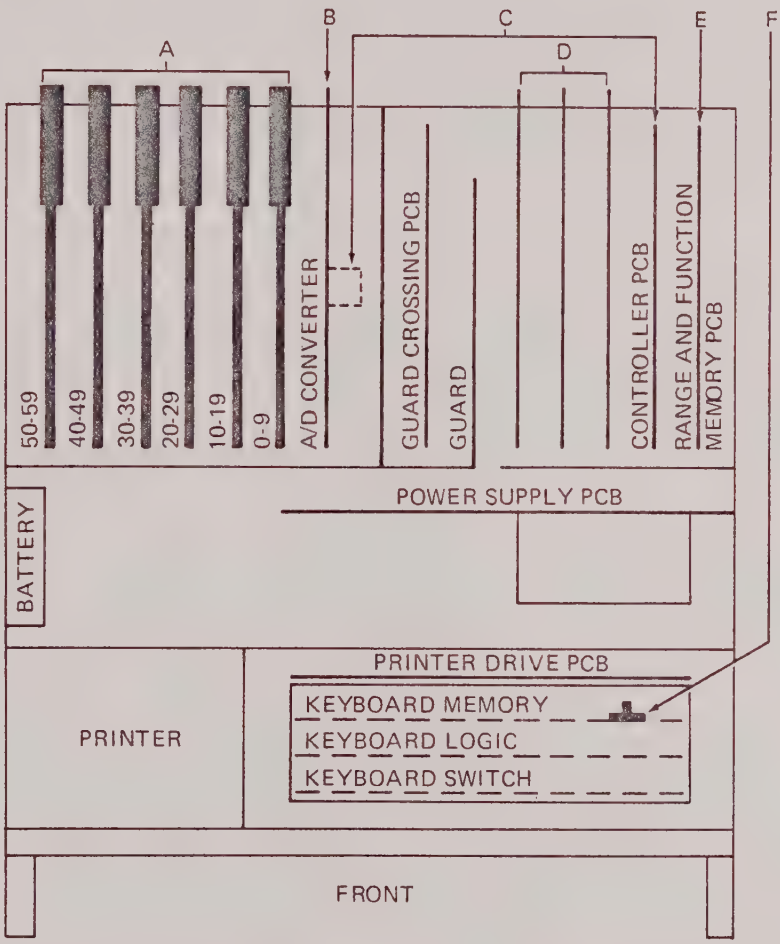
WARNING

THE INTERNAL SWITCHES ARE FOR USE BY QUALIFIED PERSONNEL ONLY. TO AVOID ELECTRICAL SHOCK, DO NOT ATTEMPT TO SET THESE SWITCHES UNLESS YOU ARE QUALIFIED TO DO SO. SEE SECTION 4 OF THIS MANUAL OR THE APPROPRIATE OPTION, AS DEFINED IN TABLE 2-2.

2-26. Several control and function enable switches are contained on the interior of the 2240C. These switches are not intended for use by the operator, and are mentioned at this time for identification purposes only. Each of the switches is named and its location defined in Table 2-2. Instructions for properly setting each switch are also referenced.

2-27. A/D Converter Speed

2-28. The measurement speed of the A/D Converter can be set by the operator for either 3 (slow) or 15 (fast) readings per second. The selection of measurement speed is accomplished by setting a slide switch on the A/D Converter PCB to the fast or slow position. The access procedure, the switch location, and the switch settings are described in Section 4, the Maintenance section.



A = SCANNER PCB'S (-04, -05, -06, -33) AND THEIR INPUT CONNECTORS (-03, -07, -08, -28, -29, -30).
B = A/D CONVERTER PCB
C = TEMPERATURE AND SCALING OPTIONS (-43,-44). THIS OPTION ALSO REQUIRES THE INSTALLATION OF LINEARIZING IC'S ON THE CONTROLLER PCB.
D = I/O INTERFACE PCB'S (-15, -16, -17, -23, AND -12, -13,-14 SERIES).
E = PROGRAMMABLE LIMITS (-41), Mx + b (-40), DATA AVERAGING (-42) IC'S LOCATED ON THE RANGE AND FUNCTION MEMORY PCB.
F = SECOND INTERVAL OPTION (-32) IC'S LOCATED ON KEY SCALE MEMORY PCB (UNDER MODE (UNDER MODE SWITCH PCB).

Figure 2-4. 2240C Option Installation Locations

Table 2-2. Internal Switch Information

SWITCH NAME	LOCATION	POSITION INFORMATION
50/60 Hz	Power Supply PCB	Section 4
115/230V ac	Power Supply PCB	Section 4
C/F	Controller PCB *3	Option 43 or 44
Block/Individual	Controller PCB *4	Section 4
Local/Remote	Controller PCB *1	Section 4
Alarms Once/All	Controller PCB *2	Section 4
Fast/Slow	A/D Converter PCB	Section 4

*1. Switch 1 selects local (OFF) or remote (ON) when Option 15 or 17 is installed.
*2. Switch 2 selects alarms once (OFF) or alarms all (ON).
*3. Switch 3 selects the C (OFF) or F (ON) scale when Option 43 or 44 is installed.
*4. Switch 4 selects the block (OFF) or individual (ON) mode of operation.

2-29. Program Memory

2-30. The 2240C is equipped with a nonvolatile memory which is impervious to power interruptions caused by either power failures or switching the instrument to power off. The memory is maintained under these conditions by a lithium battery which is switched into service when the line operated power supply is shut down. This battery will maintain the program memory for a minimum of 5 years.

2-31. Individual/Block Mode

2-32. The basic 2240C contains the memory necessary to program up to 256 individual input channels. If more than 256 channels are required, the 2240C is operated in the block mode. That is, the first 170 channels are individually programmed and the last 830 channels are programmed as 83 blocks of 10 channels each. Thus, a total of 1000 channels (170 + 830) can be programmed when the unit is operated in the block mode.

2-33. The individual or block mode of operation is selected by a switch (#4) located on the Controller PCB Assembly on the interior of the 2240C (see Figure 2-4). The individual mode is selected when the switch is in the ON position; OFF selects the block mode.

2-34. Remote Control

2-35. The 2240C is basically a manually controlled instrument. However, as shown in Figure 2-5, remote operation can be achieved through the addition of options. Currently, one of two remote control configurations is possible: remote start (of scan) or total remote control and programming. Remote start is enabled by the installation of one or more of the -12 through -14 output interface options. The addition of -15 or -17 Remote Programming Options enables total remote control capability. It also overrides the remote start capability of Options -12, -13 and -14 and, at the same time, allows switch selection of one of two remote enable modes, local or remote. The local/remote switch (SW1) is located on the Controller PCB and functions as follows:

1. Local (switch 1 set to OFF)
   Allows local or remote control of the 2240C to be selected by the position of the REMOTE switch in the SCAN CONTROL group (IN = remote, OUT = local). All front panel controls with the exception of the REMOTE, PAPER ADVANCE, and DISPLAY CONTROL switches, are disabled when remote control is selected.

2. Remote (Switch 1 set to ON)
   Allows local or remote control to be selected by a remote command. Selecting remote control disables

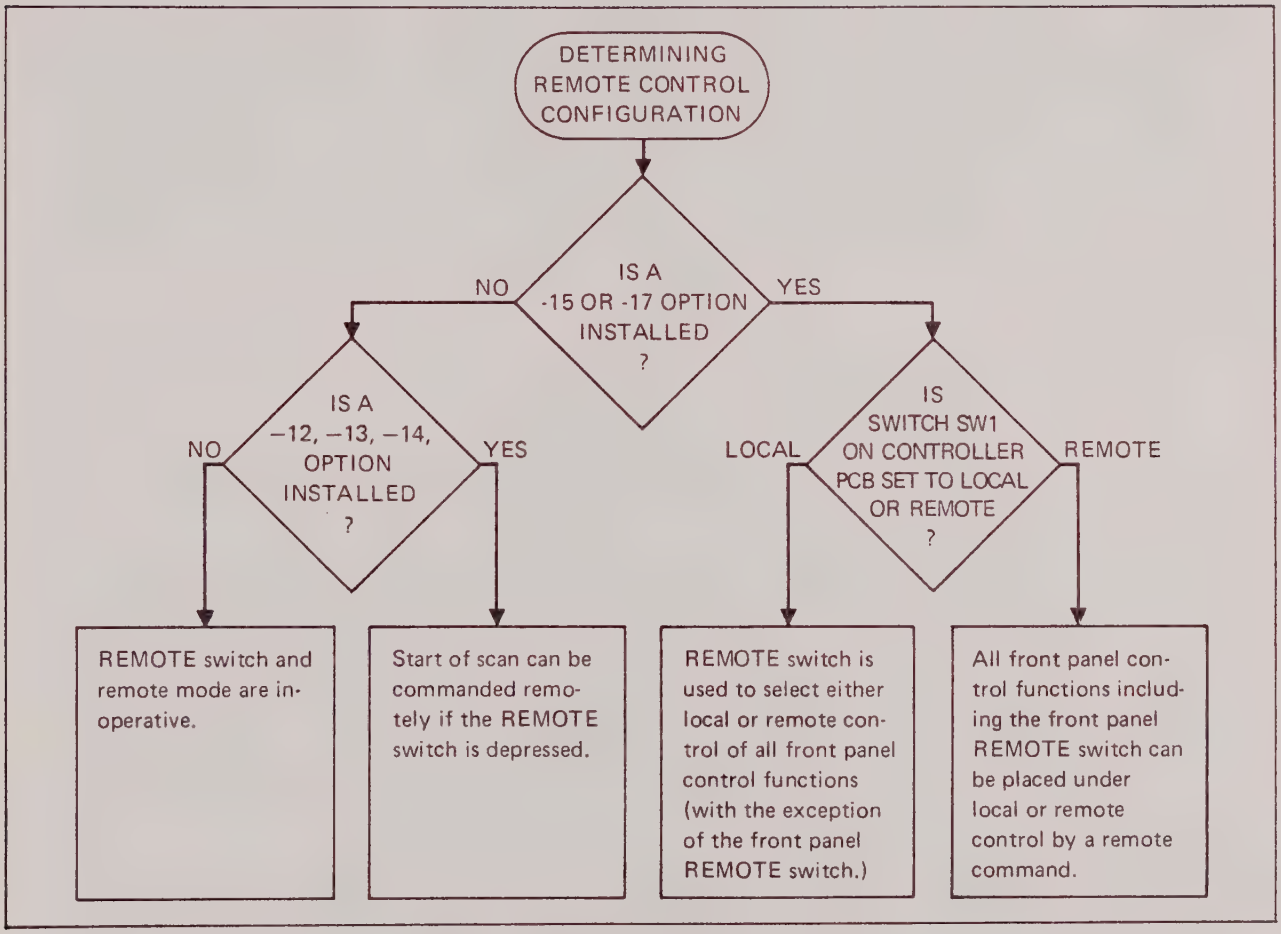

DETERMINING REMOTE CONTROL CONFIGURATION
IS A -15 OR -17 OPTION INSTALLED ?
NO
YES
IS A −12, −13, −14, OPTION INSTALLED ?
NO
YES
IS SWITCH SW1 ON CONTROLLER PCB SET TO LOCAL OR REMOTE ?
LOCAL
REMOTE
REMOTE switch and remote mode are inoperative.
Start of scan can be commanded remotely if the REMOTE switch is depressed.
REMOTE switch is used to select either local or remote control of all front panel control functions (with the exception of the front panel REMOTE switch.)
All front panel control functions including the front panel REMOTE switch can be placed under local or remote control by a remote command.

Figure 2-5. Remote Control Configurations

all front panel switches, except DISPLAY CONTROL and PAPER ADVANCE, and enables total remote control of all front panel functions. The REMOTE switch is disabled for both control modes.

2-36. Power Failure

2-37. The TIME ENTRY switch group contains a lamp which blinks to indicate the occurrence of a line power interruption during normal operation of the 2240C. The lamp begins to blink after power is restored and serves as a visual flag to indicate that the displayed date and time is in error. The restoration of the line power resets the clock to zero, allowing it to operate as an elapsed time counter. Thus, the clock provides a direct readout of the time elapsed since power was restored. Instructions for resetting the clock are given later in this section under Operation.

2-38. Output Control

2-39. The OUTPUT CONTROL switch group provides the operator with manual control over the operation of the data recording devices associated with the 2240C. The switches are divided into two separate groups: PRINTER ENABLE and EXTERNAL ENABLE. The PRINTER ENABLE switches apply only to the operation of the internal printer. The EXTERNAL ENABLE switches affect all external recording devices which are interfaced with the 2240C.

2-40. The function of the switches in both groups, as they apply to their respective recording devices, are identical with the exception of the printer's PAPER ADVANCE (paper feed) switch which is not featured in the EXTERNAL ENABLE group. Therefore, an explanation of the ALL DATA, ALARM DATA, and INTERVAL DATA switches is sufficient to explain the operation of both switch groups.

2-41. The ALL DATA, ALARM DATA, and INTERVAL DATA switches are of the push-push type and each is capable of independent operation. When all three switches are in the released or out position, the associated recording devices are inhibited from recording output data from the 2240C. Depressing one or more of the switches allows selected data to be recorded. Table 2-3 lists all of the possible switch combinations, the mode(s) in which data will be recorded, and the kind of data recorded.

NOTE

An Alarm Once/Alarm All switch (SW2) is located on the Controller PCB. It operates in conjunction with the ALARM DATA switches of the OUTPUT CONTROL group to define the output record format under alarm

conditions. See Table 2-3 for switch setting information.

2-42. Scan Control

2-43. The scan sequence can be manually controlled (when the power switch is set to POWER ON) by pressing one of the following five switches in the SCAN CONTROL group: STOP/RESET, SINGLE, INTERVAL, MONITOR, or CONTINUOUS. STOP/RESET allows termination of a previously selected scan sequence. SINGLE, INTERVAL, MONITOR, and CONTINUOUS allow separate variations of the scan sequence to be intitated. A sixth switch, REMOTE, operates in conjunction with Options -12, -13, -14, -15, and -17 and SW1 on the Controller PCB to enable the remote capabilities of the 2240C. See Remote Control earlier in this section of the manual.

NOTE

To avoid unwanted alteration of the switches in the SCAN CONTROL group, set the Power Switch to KEYBOARD PROGRAM DISABLE and remove the key from the switch.

2-44. The basic scan sequence is initiated by the SINGLE switch and is keyed to manually entered program data. A simplified sequence of events in the single scan mode is as follows:

1. The first channel relay in the program sequence closes and connects an external stimulus to the input of the A/D Converter.

2. The A/D Converter measures the input signal in terms of the programmed function (volts, millivolts, or temperature) and provides a digital display of the results.

3. The displayed value is compared against a programmed high and/or low limit value (Option -41).

4. If a recording device has been enabled, the channel, measurement, and function data are recorded. Also, prior to each scan sequence, the time of year and the fixed heading data are recorded.

5. The first channel relay is opened and the second channel relay in the sequence is closed to connect its external input to the A/D Converter.

NOTE

OUTPUT CONTROL MODES			ALARM SWITCH (SW2) SETTING*	APPLICABLE SCAN MODES				DATA RECORDED							
ALL DATA	ALARM DATA	INTERVAL DATA		MONITOR	SINGLE	INTERVAL	CONTINUOUS	NONE	ALL SCAN SEQUENCE DATA	TIME OF YEAR, CHANNEL, MEASUREMENT DATA	ONCE EACH INTERVAL	ONCE UPON ENTERING & EXITING AN ALARM CONDITION	WHENEVER AN ALARM IS ENCOUNTERED	FOLLOWED BY: (See next line.)	ALARM AT ANY CHANNEL CAUSES ALL DATA IN NEXT SCAN TO BE RECORDED
○	○	○	–	/	/	/	/	X							
○	○	●	–	/		/	/		X		X				
○	●	●	ONCE	/		/	/			X		X			
○	●	●	ALL	/	/	/	/			X			X		
○	●	●	ONCE	/		/	/			X		X		X	
									X		X				
○	●	●	ALL	/		/	/			X			X	X	
									X		X				
●	○	○	–	/	/	/	/		X						
●	○	●	–	/		/	/		X						
●	●	○	ONCE	/			/			X		X		X	
									X						
●	●	○	ALL	/			/		X				X		X
●	●	●	ONCE	/		/	/			X		X		X	
									X		X				
									X		X				

NOTES:

– = Dont't Care
/ = Any one may be selected.
– = Don't care
X = Indicates format and timing of recorded data.

** = SW2 on Controller PCB. Alarms one = OFF. Alarms all = ON.*
● = Selected
○ = Not selected

Table 2-3. Data Recorded for Various Scan Control and Output Control Modes

Channels between the first and last channels can be skipped under program control. Therefore, the measurement channels may be separated by several skipped channels. For example, the channel sequence might appear as follows: 1, 2, 8, 14, 15, 20, where channel 1 is the first channel and 20 is the last channel.

6. Steps 2, 3, and 4 are repeated.

7. The channel relay is opened and the next programmed channel relay is closed. Its input is measured, compared, and recorded.

8. Step 7 is repeated for each programmed channel until the last channel has been scanned.

2-45. Variations of the single scan mode include interval (standard interval) and continuous. The interval scan mode causes the single scan sequence to be repeated at a programmed time interval. The time interval is the time between the start of one sequence and the start of the next sequence. Interval time can be programmed from a minimum of 1 second, for standard interval, to a maximum of 23 hours, 59 minutes, and 59 seconds (23:59:59). A 1-second resolution can be achieved for any interval time within the 24-hour limit. The continuous mode causes the scan sequence to be continuously repeated with a minimum time between the end of one sequence and the start of the next sequence (typically ± 1 second). A second interval is available as an option, See Section 6-32 description and operating instructions.

2-46. The monitor scan mode allows the operator to monitor a single selected channel during a scan sequence. The monitored channel is addresssed in conjunction with the MONITOR CHANNEL switch in the SCAN FORMAT group and the DATA ENTRY keyboard. Pressing the ADVANCE ADDRESS switch incrementally advances the monitor address and allows the operator to manually scan and measure the input present at each of the accessible channels. The monitor mode is useful for both program verification and troubleshooting.

2-47. Operation of the remote mode depends upon the combination of options installed in the 2240C. Figure 2-5 defines these option combinations and the remote capabilities of each. Details concerning the remote capabilities of each option purchased are given in Section 6 of this manual.

2-48. Display Control

2-49. The DISPLAY CONTROL switch group contains three switches which allow the operator to manually assign the display to read one of three types of data (All Channels, Single Channel, or Date and Time). For example, assume that a continuous scan sequence is in progress and the operator initiates and/or executes a change in the scan format. The operator can exit the programmining mode at any time and assign the display to read either all channel measurements, selected single channel measurements, or date and time. This is accomplished by pressing the appropriate switch in the DISPLAY CONTROL group and, if SINGLE CHANNEL is selected, entering channel number, and then pressing ENTER/STEP. Reassigning the display in this manner allows the operator to enter or verify program data without interrupting the scan sequence.

2-50. Print/Record Format

2-51. Measurement data generated during a scan sequence can be recorded on the printer and/or any given external recording device interfaced with the 2240C. Examples of the recording format for any given scan sequence is shown in Figure 2-6. The example assumes the printer as the recording device.

2-52. Fixed Data

2-53. Fixed data is a six-digit number which is recorded after the data and time. The number is manually entered by the operator to identify the program, lot, run, project, etc., associated with the scan sequency and can be any number from 000000 to 999999. Once entered, the number will remain fixed until a new one is entered.

2-54. Improper Program Data

2-55. An IMPROPER ENTRY lamp is provided in the DATA ENTRY switch group to indicate that an attempt to enter illegal program data has been made. An operator error in format or data entry causes the lamp and the displayed data to begin flashing. As long as the lamp is flashing, the STEP/ENTER switch is inhibited to prevent the improper data from being entered into memory. The improper entry condition can be cleared by pressing the CLEAR ENTRY switch, or by entering new data. (When the keyboard program senses an error, it prepares itself to accept new data without the aid of the CLEAR ENTRY switch. CLEAR ENTRY is used primarily for correcting (erasing) partial entries and starting again.)

2-56. Programmable Limits

2-57. Programmable measurement limits (Option -41) are available for up to 60 separate and variable values, each of which is addressable for use by all available channels. The limits are split into 4 equal groups, (1 to 15 (LIMIT A)), (16 to 30 (LIMIT B)), (31 to 45 (LIMIT C)), and (46 to 60 LIMIT D)), and one limit from any or all groups can be assigned to a given

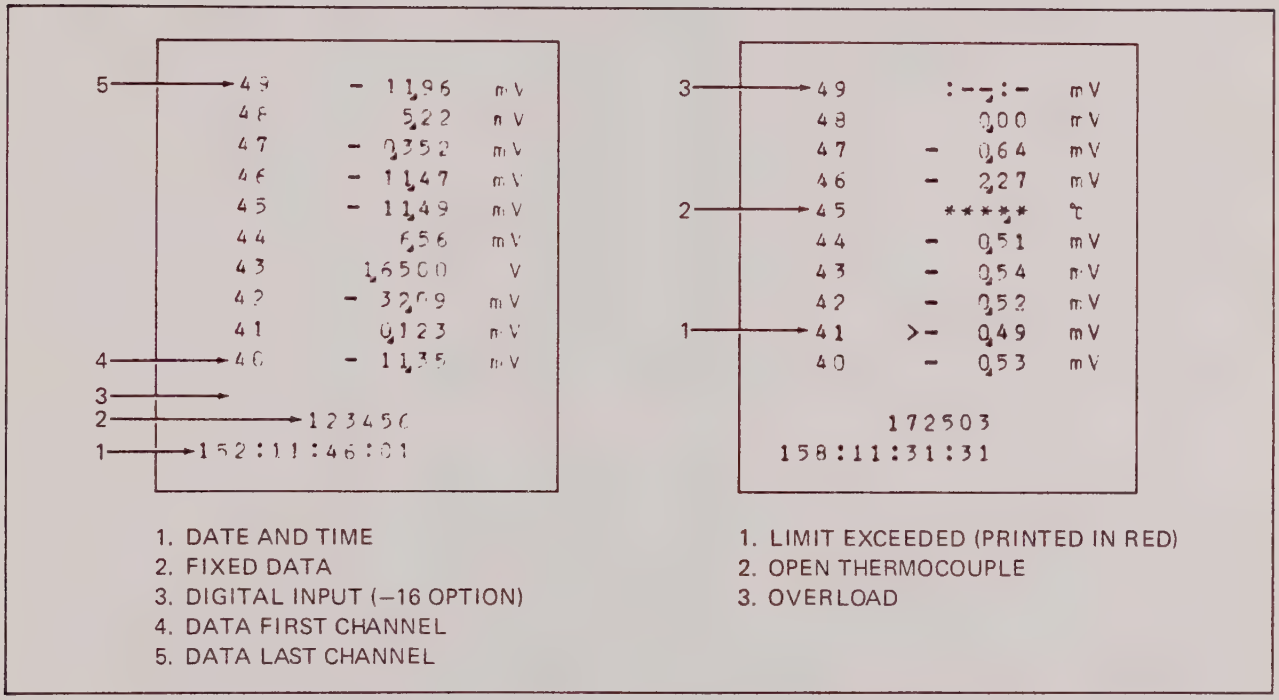


Figure 2-6. Typical Format of Printed Measurement Data

channel. However, two limits from the same group cannot be assigned to the same channel. Therefore, when a channel measurement requires two or more limits, each must be taken from a separate limit group.

2-58. The actual value of a limit word can range from a minimum of -39990 to a maximum of 39990. The least-significant digit is not programmable and is always zero. Since the programmed limit value is to be compared directly against the measurement reading, care must be taken to ensure that the limit's magnitude is compatible with the selected function and range and vice versa. For example, a limit value of 10000 can represent a limit of 10.000V, 1.0000V, 100.00 mV, 10.000 mV, 1000.0°F or 1000.0°C, depending upon the selected function.

2-59. When a limit is exceeded during a scan sequence, a LIMIT EXCEEDED lamp in the PROGRAMMING switch group begins to blink, and continues to blink until it is reset. The reset is accomplished by pressing the adjacent RESET switch. Recorded limit data is also identified as greater than (>) or less than (<) the specified limit. In addition, the printer records out-of-limits data in red for easy identification. The date and time is also printed prior to each out-of-limits measurement.

2-60. Program List

2-61. The 2240C is equipped with a program list feature which allows the operator to solicit and record the contents of the program memory. The listed information includes date and time; time intervals; fixed data; monitor channel; all available limit addresses (30 maximum) and their respective sense, polarity, and value; and channel from first to last. Channel programming includes function and limit data assigned to each channel. A sample of the program list format is given in Figure 2-7.

2-62. The program list feature should be employed both before and after entering new program data. By listing the old program, the user will know what must be added to or deleted from memory during the reprogramming process. Listing a newly entered program allows the operator to verify its accuracy.

NOTE

The program list feature requires that both the ALL DATA switch in the PRINTER ENABLE group and the RESET switch in the SCAN CONTROL switch group be depressed prior to pressing the PROGRAM LIST switch.

2-63. Audio-Tone Keyboard

2-64. As a programming aid, the 2240C includes the capability

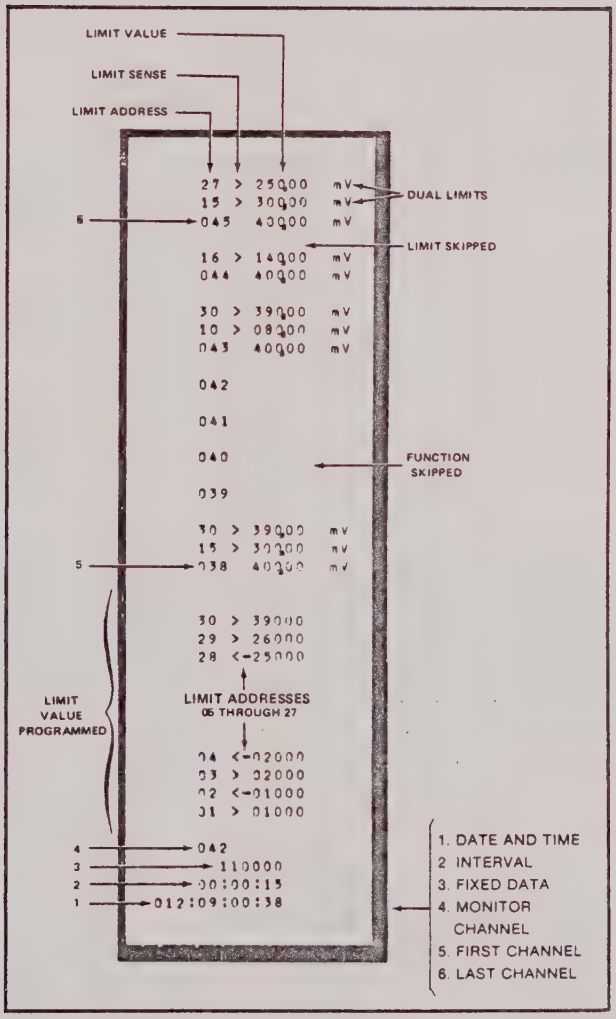


Figure 2-7. Typical Format of Program List Data

of rejecting the entry of both invalid and improperly formatted program data. The entry of each valid data character is accompanied by an audio tone when one of the keyboard switches is depressed. The tone indicates that the data is valid and has been accepted by the 2240C. The absence of the audio tone indicates that the data is either invalid or improperly formatted and has not been accepted by the 2240C.

2-65. OPERATION

2-66. Turn-On Procedure

2-67. Use of the following procedure is suggested for initial turn-on of the 2240C. With reference to the previous paragraphs turn on the 2240C as follows:

1. Connect the 2240C to line power.
2. Install available options, as required.
3. Connect interface cables, as required.
4. Press the STOP/RESET switch in the SCAN CONTROL group.
5. Insert the key in the Power switch and set it to POWER ON. The display should illuminate and read 2240c 7 for approximately 3 seconds. After the 3 seconds, the display will indicate elapsed time starting at 000 00:00:03 (3 seconds). The initial display identifies the 2240C and the control firmware version installed in the instrument.
6. Press the ADD DATA switch in the PRINTER ENABLE group.
7. Press the PROGRAM LIST switch. The program currently in memory will be printed.

2-68. Turn-Off Procedure

2-69. The turn-off procedure consists of a single step: Insert the key into the Power switch and set it to POWER OFF.

NOTE

The turn-off procedure will not clear or alter the program data present in the 2240C.

2-70. Entering Program Data

2-71. Meaningful operation of the 2240C requires the manual entry of a series of program words to define the variable

associated with a scan sequence. The procedures required to enter each variable are given in the following paragraphs. Completion of the entire series of procedures, in the order given, is recommended to familiarize the inexperienced operator with the programming requirements of the 2240C. However, it is not necessary for the experienced operator to complete the procedures in the order given. Nor, is it necessary to complete an entire procedure. Thus, variables not affected can be omitted from any of the procedures.

NOTE

Generating a written program prior to entry simplifies the programming process and ensures duplication when reentering old programs. A recommended format for a program form is given in Figure 2-8.

2-72. INITIAL PROCEDURE

2-73. Perform the following procedure prior to attempting to program the 2240C:

1. Complete the turn-on procedure given earlier in this section.

2. Set the Power switch to POWER ON.

3. Release all switches in the EXTERNAL ENABLE section of the OUTPUT CONTROL group.

NOTE

After the 2240C has been programmed, accidental alteration of the program can be avoided by setting the Power switch to KEYBOARD PROGRAM DISABLE and removing the key from the switch.

2-74. TIME ENTRY

2-75. The date and time must be updated after the turn-on procedure is performed, and after a power interruption has occurred. The POWER FAILURE/REENTER TIME lamp flashes to indicate that the clock is in error. Use the following procedure to update the date and time:

1. If the DAY display indicates the wrong date, press the DAYS switch in the TIME ENTER group. The HRS: MIN: SEC portion of the display will go blank.

FLUKE 2240C PROGRAMMING FORM

PRIMARY INTERVAL
INTERVAL _____
FIRST CH. _____
LAST CH. _____

SECOND INTERVAL
INTERVAL _____
FIRST CH. _____
LAST CH. _____

MINOTOR CH. _____
FIXED DATA _____
DAY _____

CHANNEL PROGRAM

CHANNEL ADDRESS	FUNCTION OR A/D RANGE	mx+b ADDRESS (1-30)	ADDRESS LIMIT A (1-15)	ADDRESS LIMIT B (16-30)	ADDRESS LIMIT C (31-45)	ADDRESS LIMIT D (46-60)

2240C PROGRAMMING FORM

mx+b SCALING (OPTION -40)

mx+b ADDRESS	SLOPE (m) ±X.XXXX	INTERCEPT (b) ±XXXXX	DECIMAL LOCATION OF SCALED RESULT 0 XXXXX 3 XX.XXX 1 XXXX.X 4 X.XXXX 2 XXX.XX	ENGINEERING UNITS NOTATION (0– 31) UNITS	CODE 0-31	SCALING APPLIED TO CHANNELS NUMBERED:
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						
26						
27						
28						
29						
30						

ENGINEERING UNITS NOTATION TABLE

PROG. CODE	E/U	PROG. CODE	E/U	PROG. CODE	E/U	PROG. CODE	E/U
01	ACA	11	psi	21	ACW	31	%
02	ACmA	12	s	22	DCW	0	BLANK
03	DCA	13	ms	23	kW		
04	DCmA	14	μs	24	mW		
05	μA	15	ACV	25	μW		
06	dB	16	dBV	26	°C		
07	μF	17	DCV	27	°F		
08	Hz	18	kV	28	Ω		
09	kHz	19	mV	29	kΩ		
10	MHz	20	μV	30	MΩ		

DATA AVERAGING (OPTION -42)

GROUP AVERAGE

GROUP SIZE _____
INTERVAL _____
FIRST CHANNEL _____
LAST CHANNEL _____
SIZE OF GROUP _____

TIME AVERAGE

FIRST CHANNEL _____
LAST CHANNEL _____
SKIPPED CHANNELS _____
NUMBER OF SCANS PER AVG. _____
INTERVAL _____

Figure 2-8. 2240C Program Form, Recommended Format (cont)

2. On the DATA ENTRY keyboard, serially enter the Julian day of year or an equivalent three-digit date code. As each digit is entered, it will be presented on the DAY portion of the display. If the entry was made incorrectly, press the CLEAR ENTRY switch on the DATA ENTRY keyboard and then reenter the proper day.

NOTE

When using the DATA ENTRY keyboard, it is not necessary to enter leading zeros.

3. After the desired day is displayed, enter it into memory by pressing the ENTER/STEP switch on the DATA ENTRY keyboard. The DATA display should now be illuminated.

NOTE

When the HR, MIN, SEC switch is pressed, the clock is not actually stopped. It continues to run and can be recalled at any time prior to pressing the ENTER/STEP switch by pressing DATE AND TIME.

4. Press the HR MIN SEC switch in the TIME ENTRY group. The DAY portion of the display should go blank.

5. Serially enter the desired time on the DATA ENTRY keyboard hours first and seconds last. Remember that the clock is to be restarted at some future time and should be synchronized with the true time of day. Therefore, the time entered on the keyboard should agree with the time at which the clock is to be started.

6. Synchronize and start the clock by pressing the ENTER/STEP switch.

2-76. SCAN FORMAT

2-77. The scan format program involves the variables which define the scope of a scan sequence. These include: fixed data, first channel, last channel, time interval, and monitor channel address. Use the following procedure to program the scan format:

1. Press the FIXED DATA switch in the SCAN FORMAT group. The six digits currently in memory will be

presented on the DATA display.

2. If the fixed data is incorrect, serially enter the desired data on the DATA ENTRY keyboard (MSD first) and press the STEP/ENTER switch. If the original data is correct, no action is required.

3. Press the FIRST CHANNEL switch in the SCAN FORMAT group. The first channel address currently in memory will appear on the CHANNEL display.

4. If the channel displayed is incorrect, serially enter the desired first channel on the DATA ENTRY keyboard and press the ENTER/STEP switch. If the original channel is correct, no action is required.

5. Press the LAST CHANNEL switch in the SCAN FORMAT group. The last channel currently in memory will appear on the CHANNEL display.

6. If necessary, enter the correct last channel on the DATA ENTRY keyboard and press the ENTER/STEP switch.

7. Press the INTERVAL HR MIN SEC switch in the SCAN FORMAT group. The time interval currently in memory will be displayed in hours, minutes, and seconds on the DATA display. (See Option -32 in Section 6 for second interval operation.)

8. If necessary, enter the desired time interval on the DATA ENTRY keyboard and press the ENTER/STEP switch.

9. Press the MONTIOR CHANNEL switch in the SCAN FORMAT group. The current address of the channel to be monitored will appear on the CHANNEL display.

10. If a new monitor channel is desired, enter it on the DATA ENTRY keyboard and press the ENTER/STEP switch.

2-78. LIMITS PROGRAMMING

2-79. The memory required to program measurement limits is available only when the 2240C is equipped with the set-point limits option. The following procedure assumes that a Limit Set-Point Option (-41) has been installed in the 2240C. Prior to attempting to program the limits, the operator should familiarize himself with the limit capabilities available in the 2240C. Use the following procedure to assign limit magnitude, polarity, and high or low sense to one or more of the 60 possible limit addresses. To simplify programming, the limits assigned to each address should be determined prior to entering limit address data

in the Channel Programming procedure.

NOTE

When two or more limits are associated with a single measurement, care must be taken to ensure that the limits appear in separate address groups 1 through 15 for group A, 16 through 30 for group B, 31 through 45 for group C, and 46 throught 60 for group D. High or low sense can be assigned to any address in either group. However, two limits within one group cannot be utilized simultaneously.

1. Press the LIMITS ENABLE switch in the PROGRAMMING switch group. The ENTER ADDRESS lamp will light.

2. Enter the desired limit address (1 through 30) on the DATA ENTRY keyboard and verify its correctness on the CHANNEL display.

NOTE

If a selected channel is larger than 60, the channel display and the improper entry LED will flash when ENTER/STEP is pressed.

3. Press the ENTER/STEP switch on the DATA ENTRY keyboard. The ENTER ADDRESS lamp will go out and the ENTER SENSE lamp will light.

4. Enter HI LIMIT or LO LIMIT as desired on the DATA ENTRY keyboard. The ENTER SENSE HI/LO lamp will indicate the selected sense. Press the ENTER/STEP switch. The ENTER SENSE lamp will go out and the ENTER VALUE lamp will light.

5. Enter the numeric value of the addressed limit on the DATA ENTRY keyboard. If the value is to be negative, press the minus (-) key before, during, or after the numeric value is entered. Positive values do not require a polarity entry.

NOTE

The number of digits in a limit value should be compatible with

the measurement function it is to be compared with. For example, a limit value of 10000 can represent a limit of 10.000V, 1.0000V, 100.00 mV, 10.000 mV, 1000.0°F or 1000.0°C, depending upon the selected function.

6. Press the ENTER/STEP switch. The ENTER VALUE lamp will go out and the ENTER ADDRESS lamp will light.

NOTE

Limit values outside the range of +39990 may not be entered. The least significant digit of the limit value is automatically set to zero.

7. Progress to the next applicable limit address by either entering it via the DATA ENTRY keyboard and pressing the ENTER/STEP switch, or pressing the ADVANCE ADDRESS switch until the correct address is displayed.

8. Update the limit sense and limit value by repeating steps 4, 5, and 6 of this procedure.

9. Repeat steps 7 and 8 to update any additional limits for use in the scan sequence.

2-80. CHANNEL PROGRAMMING

2-81. Use the following procedure to assign the appropriate measurement function, limits address(es), and mx + b addresses to each channel included in a scan sequence; i.e., first channel to last channel as defined in the Scan Format program procedure:

1. Press the CHANNEL ENABLE switch in the PROGRAMMING group. The ENTER ADDRESS lamp will light.

2. Using the DATA ENTRY keyboard, enter the address of the first channel in the scan sequence and press the ENTER/STEP switch. The selected channel and the currently programmed function will be displayed. The ENTER ADDRESS lamp will go out and ENTER FUNCTION will light.

3. On the DATA ENTRY keyboard, press the appropriate voltage/temperature range (or skip) for the display channel, and then press the ENTER/STEP switch. The ENTER FUNCTION lamp will go out and the ENTER ADDRESS mx + b lamp will light.

NOTE

All measurement functions are available as options. Therefore, prior to attempting to select a function, determine whether or not it is available in your 2240C. The IMPROPER ENTRY lamp will light when an invalid function is selected. The condition is cleared by pressing the CLEAR ENTRY switch or selecting an available funtion.

NOTE

When the ENTER ADDRESS mx + b lamp lights, the address of the mx + b function assigned to that channel is shown on the DATA display. If a mx + b is not currently assigned, the display will read S S S for skip.

4. If mx + b scaling is required, enter its address on the DATA ENTRY keyboard and press the ENTER/STEP switch. If scaling is not required, press the SKIP switch adjacent to the ENTER ADDRESS mx + b switch and press the ENTER/STEP switch. In either case, the ENTER ADDRESS mx + b lamp will go out and the ENTER ADDRESS LIMIT (A.B.C.D.) will light, as well as the LIMIT A lamp in the upper right portion of the display.

5. If a limit from address group A (1-15) is required, enter its address on the DATA ENTRY keyboard and press the ENTER/STEP switch. If a limit from address group A is not required, press the SKIP switch adjacent to the ENTER ADDRESS LIMIT switch and press the ENTER/STEP switch. In either case, the LIMIT A Lamp in the display will go out and the LIMIT B Lamp will light.

6. Either skip or enter a limit address code from address group B (16-30) and press the ENTER/STEP switch. The LIMIT B lamp in the display will go out and the LIMIT C lamp will light. Repeat this step for group C (31-45) and group D (46-60). After the group D address is entered, the ENTER ADDRESS LIMIT (A.B.C.D) lamp will go out and the ENTER ADDRESS lamp will light.

7. Press the ADVANCE ADDRESS switch. The CHANNEL display will advance to the next channel in the sequence and the ENTER FUNCTION lamp will light.

8. With reference to the following notes, repeat steps 3 through 7 of this procedure for each channel in the scan sequence.

   a. Any combination of channels between the first and last channels can be skipped by sequentially pressing the SKIP and ENTER/STEP switches when the ENTER FUNCTION lamp is lit. When a channel is skipped, the mx + b address and limit address will be ignored.

   b. When a series of channels require identical function, mx + b, and limit data, program the first channel in the series using the above procedure. Then alternately press the ADVANCE ADDRESS and the REPEAT switches for each like channel.

2-82. SINGLE CHANNEL PROGRAMMING

2-83. Use the following procedure to address and select the single channel to be displayed:

1. Press the SINGLE CHANNEL switch in the DISPLAY CONTROL group. The current address of the single channel will appear on the CHANNEL display.

2. If a new single channel is desired, enter it on the DATA ENTRY keyboard and press the ENTER/STEP switch.

3. The displayed channel can be advanced by pressing the ADVANCE ADDRESS switch.

Section 3
Theory of Operation

3-1. INTRODUCTION

3-2. This section contains an overall functional description followed by a Block Diagram Analysis of the Model 2240C Data Logger. Both descriptions are supported by simplified block diagrams. Detailed schematics of the individual pcb assemblies are given in Section 8 of this manual.

3-3. OVERALL FUNCTIONAL DESCRIPTION

3-4. The 2240C, as shown in Figure 3-1, is a data processor and recorder which is expandable, through the use of optional plug-in modules, into a user designed data acquisition system capable of servicing up to 1000 channels of guarded analog data. Logically, the 2240C can be divided into two major sections, analog and digital. The analog section comprises the Scanner PCBs and the A/D Converter. The remaining blocks comprise the digital section.

3-5. The analog section of the 2240C is an electrically isolated scanner and A/D converter which is used to interface the individual channels of analog data with the control logic contained in the digital section. Analog data is presented to the analog section through a series of plug-in relay scanner pcbs (up to 100 ten-channel scanner pcbs can be serviced). The individual channels are energized under digital control, and the selected channel data is measured and digitized by a dual-slope A/D Converter (the analog portion of which is contained on the A/D Converter PCB while the digital portion is contained on the Guard Crossing PCB). After each channel measurement is completed, the Guard Crossing PCB transfers the digitized measurement data across an optical isolator to the digital section. All additional processing of measurement data (e.g., display, recording and comparison) is accomplished by the digital section.

3-6. The digital section of the 2240C is a bus oriented system based upon a four-bit-parallel microprocessor (which is an integral part of the controller). Three buses are used to route data within the digital section. Two are unidirectional control buses, and the third is a bidirectional data bus (which is used to exchange data between the microprocessor and the other elements of the digital section).

3-7. The control buses (four lines each) are identified as Control Bus A and Control Bus B, and are mutually exclusive in operation. Both control buses are used by the controller to transmit address data to the various elements (peripherals) of the digital section. When a particular peripheral is addressed, communications between it and the Controller are possible via the bidirectional Data Bus. The address codes and assignments for both Control Bus A and Control Bus B are given in Table 3-1.

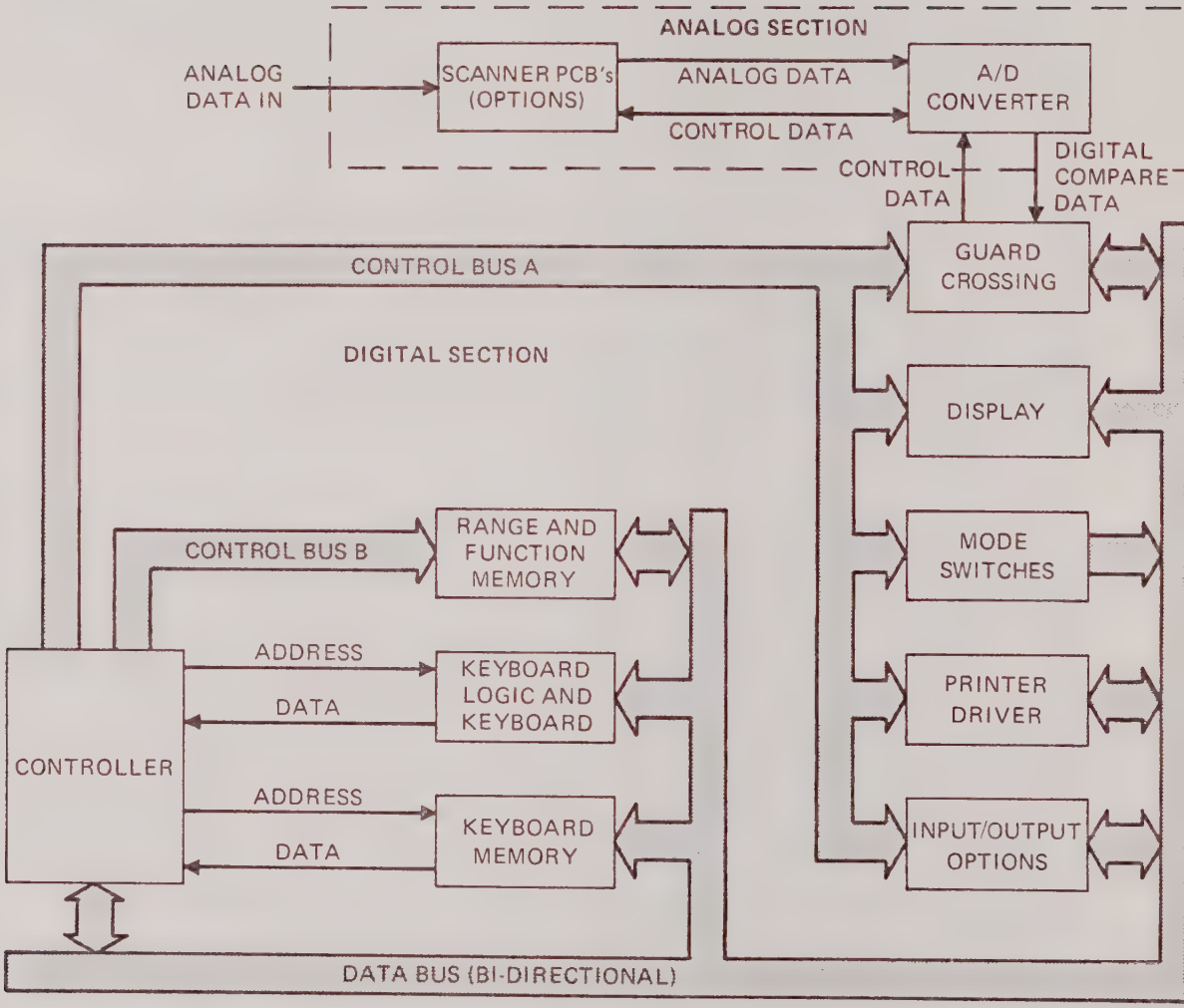


Figure 3-1. 2240C Data Logger, Simplified Block Diagram

Table 3-1. Control Bus Address Codes

CONTROL BUS A		CONTROL BUS B	
CODE	ASSIGNMENT	CODE	ASSIGNMENT
0000	Null Character	0000	Null Character
0001	Guard Crossing Transmit	0001	Not Used
0010	Guard Crossing Receive	0010	Not Used
0011	Guard Crossing Status	0011	Not Used
0100	Output Receive	0100	Not Used
0101	Printer Receive	0101	Not Used
0110	Remote/Output Status	0110	Not Used
0111	Input Transmit	0111	Not Used
1000	Mode Switch Transmit	1000	Keyboard Receive
1001	Display Receive	1001	Keyboard Transmit
1010	Not Used	1010	Keyboard Status
1011	Remote Received	1011	Not Used
1100	Configuration Transmit	1100	Alarm Output Receive
1101	Printer/Interval Status	1101	Not Used
1110	Remote Transmit	1110	Not Used
1111	Not Used	1111	Not Used

3-8. Each address code, in addition to addressing a particular peripheral, also defines the communication function the peripheral is to perform (i.e., transmit or receive). Therefore, peripherals which are capable of both transmitting and receiving data are assigned multiple address codes. Other peripherals, such as the display, are only capable of receiving data, and therefore, require only one address code. Similarly, the Mode switches are assigned a single address code because they are only capable of transmitting data.

3-9. When an address code is placed on either of the control buses (A or B), the corresponding peripheral is enabled to perform the solicited function; transmit or receive. If a transmit function is enabled, (e.g., the Mode switches are addressed to transmit data on the Data Bus when a binary coded 8 (1000) is placed on Control Bus A), the responding peripheral immediately places its first 4-bit character onto the Data Bus. When the controller reads the Data Bus it generates an In strobe. This strobe is used by the addressed peripheral to move the next character for transmission onto the Data Bus. The process is repeated until all of the characters (determined by the controller) have been transmitted. At that time, the controller removes the address code from the Control Bus and replaces it with a Null-Character Code, 0000. If the receiver function is enabled, the process is similar. However, data moves from the controller to the addressed peripheral, and an Out strobe is generated to allow the peripheral to receive each data character.

3-10. Four of the peripherals perform functions which are not normally synchronized by the controller. They are the Power Supply, the Printer, the -15 and -17 Options (Remote Programming), and the Guard Crossing. The power supply generates a 1 Hz clock pulse to maintain the time-of-year clock, the Printer records data supplied via the Data Bus, the -15 and -17 Options enter remote programming data, and the Guard Crossing sends A/D measurement data to the controller via the Data Bus. Since the operation of these peripherals is not synchronized with the controller, each is provided with an interrupt line (IRQ) to notify the controller that they are ready to perform their function. When any one of the units pull the IRQ line, the controller responds by interrupting its normal data processing routine and sequentially requesting the status of each of the four peripherals: Guard Crossing, Printer, -15 or -17 Option, and Power Supply, respectively. The interrupting unit is identified by its status code and serviced as necessary. When multiple interrupts occur, priority is established by the status interrogation sequence. (The interrupt circuit for the Power Supply's 1 Hz output is actually contained on the Controller PCB.)

3-11. BLOCK DIAGRAM DESCRIPTION

3-12. Introduction

3-13. A block diagram description of the 2240C is given in the following paragraphs. The description is keyed to the detailed block diagram shown in Figure 3-2. Each block or group of blocks represents a pcb assembly which is supported by a detailed schematic in Section 8 of this manual.

3-14. Controller PCB Assembly

3-15. The Controller PCB Assembly contains the microprocessor set and its associated program memory and control circuitry. The microprocessor set consists of CPU (U9), Memory Interface (U10) and eight RAMs standard, 12 total with -42 option. ROMs U12, U11, U9, U8, and U14 comprise the program memory. Supporting control circuits include a 2Ø (two phase) Clock Generator, the Interrupt Circuit and the configuration switches.

3-16. MICROPROCESSOR SET

3-17. The microprocessor set solicits and responds to program data stored in four separate locations: the Control Program ROMs, the Range and Function memory, the Temperature ROMs, and the Keyboard Memory (peripheral). The Control Program ROMs contain the program data that determines the basic characteristics of the 2240C. The Temperature ROMs contain alternate temperature measurement programs that can be enabled under program control. The Keyboard Memory (which can be either manually programmed via the front panel keyboard or remotely reprogrammed via the -15 or -17 Option, when installed) provides the microprocessor set with the following data: First Channel, Last Channel, Monitor Channel, Interval, and Fixed Data. Second Interval Time, and First and Last Channels for the second interval are provided when the -32 Option is installed.

3-18. To access data in one of the four program data locations, the CPU (U16) generates a 12-bit address in the form of 3-serial, 4-bit characters. These characters are presented to the Memory Interface (U17) where they are assembled into a 12-bit parallel address word and placed on the ROM Address Bus. The address word is then presented in parallel to each of the four program data locations. To ensure a response from only the desired program data location, an additional location-enable line is required. Control data for this line is derived from program content. RAM U32, 1-of-10 decoder U5, and RS flip-flop U15 generate the enable for the Temperature and the Control Program ROMs. The Range and Function memory and the Keyboard Memory are enabled by RAM U29 and 1-of-10 decoder U6 via the Program Memory (PM) output of U17.

3-19. Program data from the addressed program-data location is placed on the 8-bit ROM Data Output Bus (01 through 08) and read by the Memory Interface. The data is then either returned to the CPU for further processing or placed on the Data Bus for use by the peripheral I/O pcb assemblies.

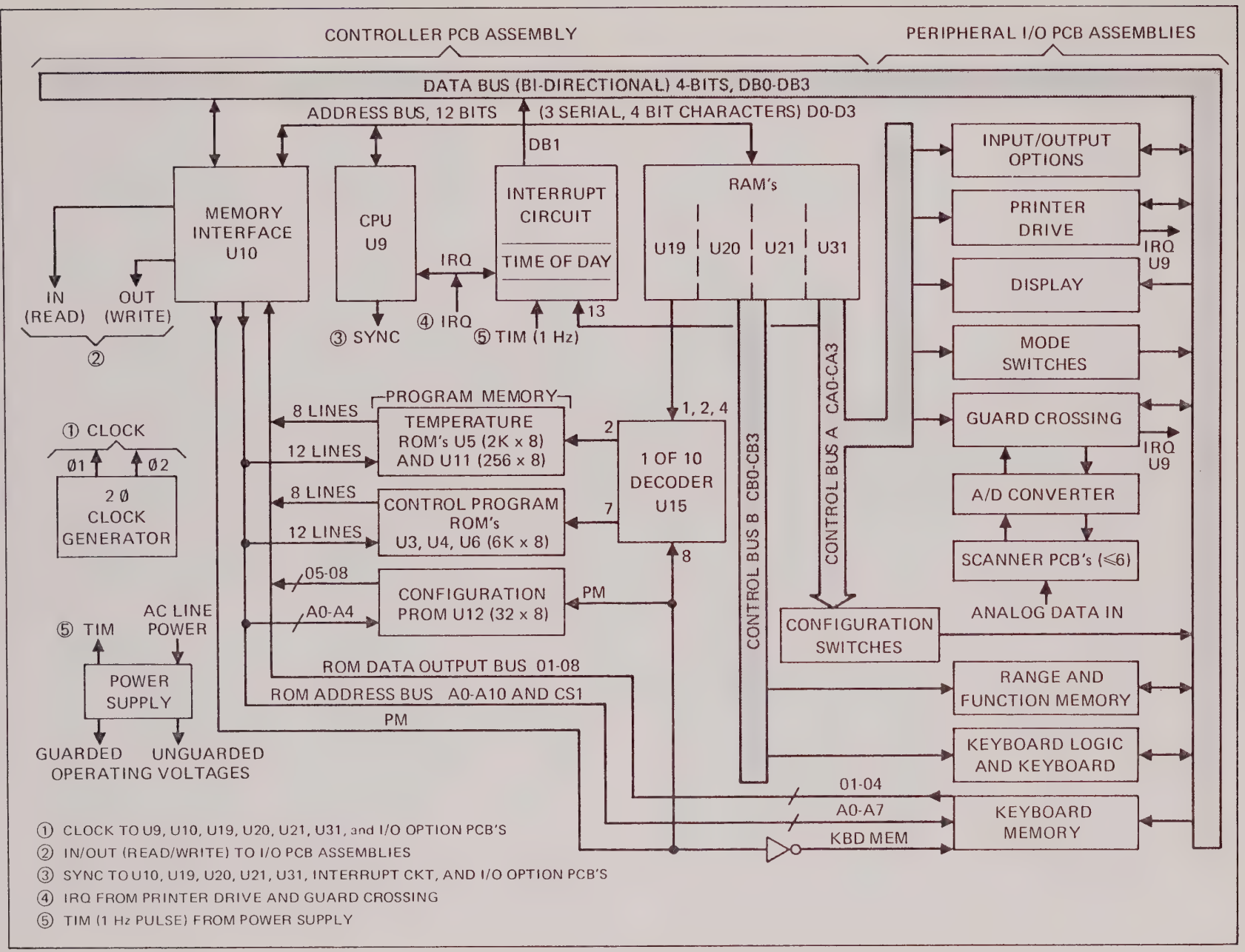


Figure 3-2. 2240C Data Logger, Detailed Block Diagram

3-20. Since the control Program ROMs (U12, U11, and U8) contain the instructions which determine the characteristics of the 2240C, they must be addressed when the unit is initially energized. This is accomplished by forcing U32 to present a binary coded 7 (0111) to the 1-of-10 decoder U5; thereby enabling the Control Program ROMs to respond to the initial 12-bit address on the ROM Address Bus. Subsequent program data locations are accessed under the direction of the Control Program.

3-21. Control and response data to and from the Controller PCB Assembly is routed over the bidirectional Data Bus under the direction of the Control Program ROMs. The appropriate peripheral and the desired response (transmit or receive) are solicited by address codes placed on Control Bus A or Control Bus B. These codes are derived from the control program via RAMs U28 and U27. If the addressed peripheral is to return (transmit) data to the Controller PCB Assembly, the Memory Interface U17 generates an In strobe to retrieve character-serial data via the Data Bus. If the peripheral is to receive data from the Controller PCB Assembly, the Memory Interface generates an Out strobe after it places each character on the Data Bus. This enables the addressed peripheral to synchronize the serial I/O data with the Controller PCB Assembly.

3-22. TWO PHASE CLOCK GENERATOR

3-23. The microprocessor set is synchronized to a 2-phase crystal controlled clock. The clock circuitry consists of a synchronous counter U4, a 5.185 MHz crystal Y1, gates U1 and U3, and a level shifter U2.

3-24. In operation, crystal Y1 provides the time base (1/5.185 MHz) for a free-running oscillator. Counter U4 divides the oscillator output by seven and presents its Q1 (2) and Q2 (4) outputs to gates U3B (Ø1) and U3C (Ø2) for decoding. The decoded outputs are then presented to U2 where the two TTL output signals are shifted to the +5 and -10 volt levels required by the microprocessor set. The timing of the 2-phase clock is shown in Figure 3-3.

3-25. CONFIGURATION SWITCHES

3-26. The positions of the four configuration switches, SW1 through SW4, are read by the microprocessor set when the 2240C is powered up. The switches are used as selectable variables which operate in conjunction with the data stored in program memory. Switch SW2 selects Alarms All or Alarms Once. Switch SW1 selects the Local or Remote control mode. Switch SW3 defines the temperature scale, ^{o}C or ^{o}F, and SW4 selects the individual or block mode of programming.

3-27. After the 2240C is energized, the microprocessor Set places a binary coded 12 on Control Bus A. The address is

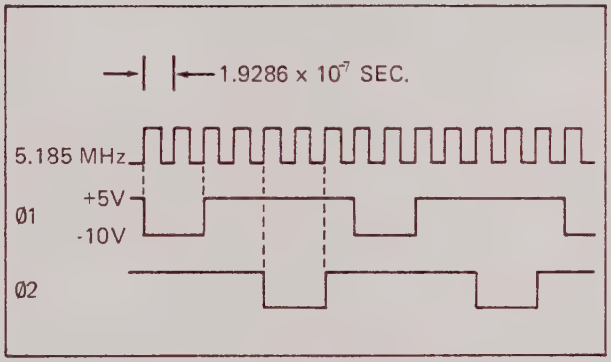


Figure 3-3. Two Phase Clock Timing Diagram

detected by U33B which, in turn, enables the tri-state driver U38. All switch positions are placed on the Data Bus by U38 and read by the CPU when the Memory Interface generates an In strobe. Switch data is assigned to the Data Bus as follows: S1-1 to DB2, S1-2 to DB3, S1-3 to DB1, and S1-4 to DB0. After the switch data is read, the binary coded 12 address is removed from Control Bus A and the tri-state driver U38 reverts to its normal high impedance output state.

3-28. INTERRUPT CIRCUIT

3-29. The interrupt circuit comprises flip-flops U35, gates U34, U37, and U33A, tri-state buffer U38 (E2 half), and transistor Q2. The circuit operates in conjunction with the 1 Hz time interval marker (TIM, from the Power Supply) to update the date and time in the CPU. When a TIM pulse is generated (+5V dc), the next CPU Sync pulse sets flip-flop U35B. Subsequently, the IRQ line is pulled low by transistor Q4. As the CPU interrogates the status of the interrupt peripherals (Guard Crossing, Printer and Power Supply), it places a binary coded 13 on Control Bus A. This address is detected by U33A which, in turn, enables U38. The output of U35A is routed through U38 and a binary coded 2 is placed on the Data Bus (DB1). An In strobe is generated by the microprocessor to read the Data Bus and, thereby update the current date and time. As the Data Bus is read, the in strobe sets flip-flop U35 and the IRQ line is cleared. The next Sync pulse clocks flip-flop U35 to remove the data from the Data Bus. When the TIM probe returns low, the next Sync pulse clock flip-flops U35 to the reset state so that the process can be repeated when the next TIM pulse occurs.

3-30. Keyboard Switch and Keyboard Logic PCB Assemblies

3-31. The Keyboard Switch and Keyboard Logic PCB Assemblies, as shown in Figure 3-4, are controller peripherals designed to function as a unit and to provide the operator interface necessary for local control and programming of the 2240C. In the local mode, program data is manually presented to the 2240C through a series of momentary-type switches that comprise a portion of the Keyboard Switch PCB Assembly. When any keyboard switch is pressed, it is detected by the Keyboard Logic PCB and analyzed by the controller to determine its validity. In response to a valid input, the controller interrogates the Keyboard Logic, accepts the entered data, and returns a series of keyboard instructions to prompt the subsequent action of the operator. These instructions always include an audio tone to indicate the acceptance of entered data, and may include an illuminated prompting LED if a particular programming sequence is required. Additional prompting LEDs are used to notify the operator of abnormal operating conditions. They are: POWER FAILURE to indicate the interruption of line power, IMPROPER ENTRY to flag the attempted entry of illegal data or format, and LIMIT EXCEEDED to indicate that a measurement value has exceeded its programmed limit value.

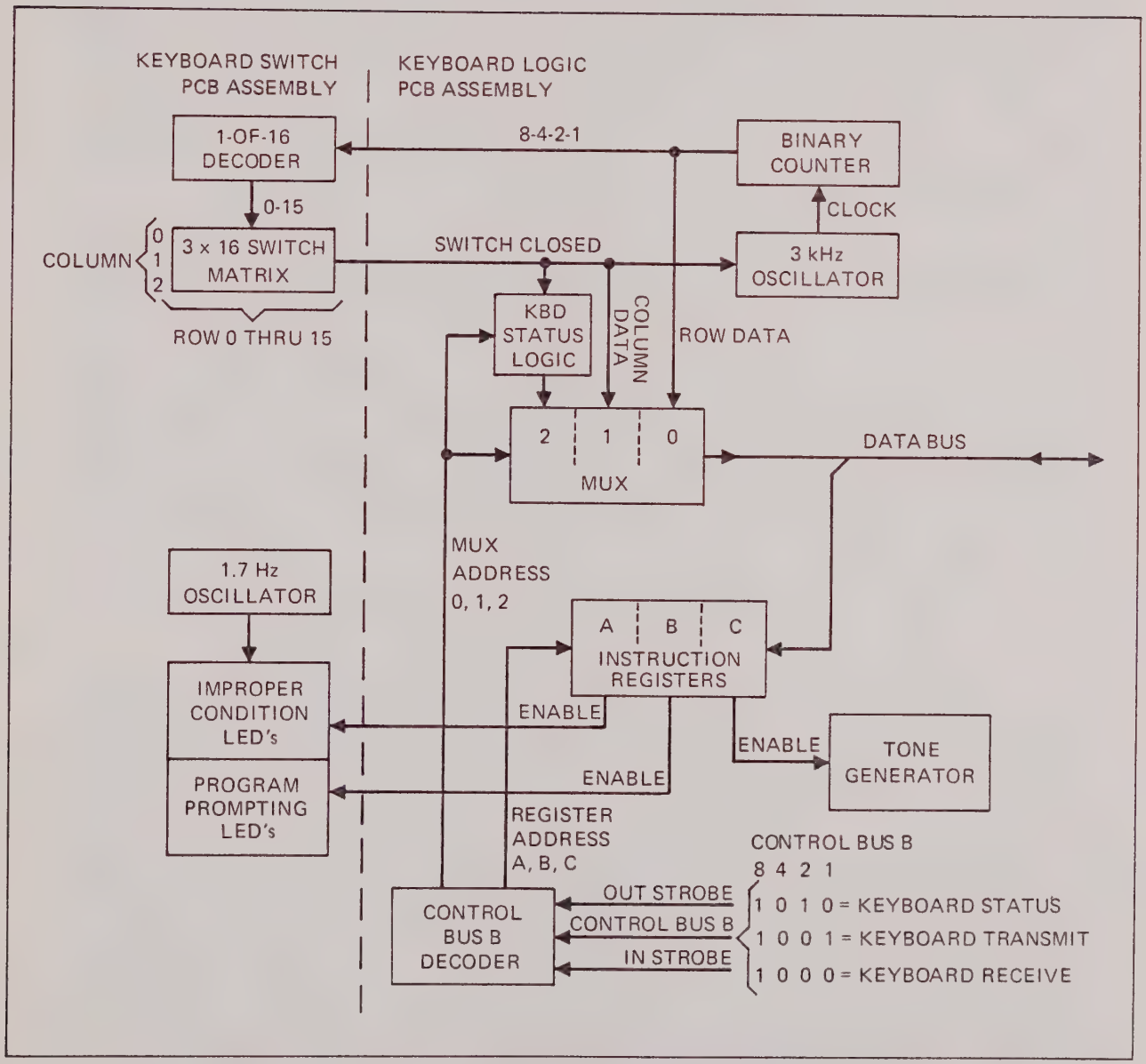


Figure 3-4. Keyboard Switch and Keyboard Logic, Simplified Block Diagram

3-32. Operation begins when power is applied to the circuit. A 3 kHz oscillator free runs to provide a clock input to a 4-bit binary counter which, in turn, drives a 1-of-16 decoder. The decoder outputs are connected to the individual rows of a 3-column by 16-row switch matrix. Since the counter continually scans the matrix rows, a switch depression in any row will cause one of the three columns buses to go low. When this occurs, a switch-closed signal is generated and the 3 kHz oscillator is stopped. As a result the matrix coordinates of the depressed switch are identified. The counter output defines the matrix row and the low column output defines the matrix column. When the matrix switch is released, the scanning cycle is resumed.

3-33. Periodically, the controller interrogates the status of the Keyboard Logic PCB to see if an attempt to enter program data is being made. The interrogation is initiated when the controller places a binary coded 10 on Control Bus B. A decoder on the Keyboard Logic PCB detects the code and enables channel 2 of three-channel multiplexer (MUX). Channel 2 data is placed on the Data Bus and returned to the controller. If the controller recognizes the following two conditions on the Data Bus (DB0 through DB3) it places a binary coded 9 on Control Bus B as a command for the keyboard to transmit data. If the conditions are not met, the controller ignores the response and resumes its other activities.

DB0 - A keyboard switch must be depressed.
DB3 - The depressed switch must represent new data (i.e., it has not been read since it was last depressed).

3-34. The receipt of a keyboard transmit code (binary 9) causes the Control Bus B Decoder to enable Channel 1 of the three channel multiplexer, and thereby place the closed-switch, column-coordinate data (Column 0, 1, or 2) onto the Data Bus. An In strobe from the Controller reads the Data Bus and then causes the Control Bus Decoder to enable Channel 0 of the 3 channel multiplexer. Channel 0 places the closed-switch row-coordinate data (0 through 15) onto the Data Bus. The controller again reads the Data Bus by generating an In strobe, the trailing edge of which is used to remove the keyboard transmit code from Control Bus B and to set a new-data flip-flop in the keyboard status logic. This flip-flop is reset when the depressed switch is released. However, when set, it inhibits the controller from reading a single switch depression more than once.

3-35. The controller returns response data to the keyboard after every accepted keyboard transmission. A series of instruction registers (A, B, and C) store the response data and drive the appropriate tone generator or front panel LEDs. Response data is presented to the registers via the Data Bus and is loaded into the individual register as a series of three 4-bit characters. Register A is enabled when the Controller places a keyboard receive code (binary coded 8) on Control Bus B, and is

loaded when the Out stobe occurs. On the trailing edge of the Out strobe the Control Bus B Decoder enables Register B and allows it to be loaded on the next Out strobe. Register C is loaded in a similar manner.

3-36. The +5V dc drive for the improper condition LEDs is derived from the output of a 1.7 Hz oscillator located on the Keyboard Switch PCB Assembly. When any one of the LEDs is activated (via register A) the oscillator causes it to flash.

3-37. Keyboard Memory PCB Assembly

3-38. The Keyboard Memory PCB Assembly is a controller peripheral designed to function as a nonvolatile memory for storing scan format, scan control, output control, and limit value data entered by the keyboard or the -15 or -17 Option if installed. This includes: fixed data, first channel, last channel, interval, single channel, and monitor channel.

3-39. The simplified block diagram shown in Figure 3-5 identifies the functional logic contained on the Keyboard Memory PCB Assembly, and defines the major flow of data to, from, and within the pcb. Prior to initial turn-on, previously entered program data is stored in a series of RAMs and is maintained by a 5.9V lithium battery. The battery is switched into the circuit during the absence of the Power-On-Reset (POR) signal (high during power-on) as derived from the Power Supply PCB. When power is turned on, the RAM memory is switched to operate from the unguarded +5V dc (line powered) power supply.

3-40. Memory is enabled for either read or write applications when both the Power-On-Reset signal from the power supply, and the Keyboard Memory (KBD MEM) signal from the controller are present as Keyboard Memory PCB inputs. These signal are ANDed to enable a series of tri-state drivers which normally isolate the RAM and prevent it from being read or written into.

3-41. After memory is enabled, read/write operations can be executed in a character-serial fashion. An 8-bit Address Bus, A0 through A7, is operated by the controller and used to select a particular location within the RAMs. The upper four bits of this bus, A4 through A7, drive a 1-of-10 decoder to develop the individual IC memory addresses, while the lower four bits, A0 through A3, define the unique character (word) location within the addressed IC. Data present in the addressed memory location is placed onto the Output Bus (01 through 04) and, if desired, can be read by the controller. If a word is to be written into the addressed location, the controller places the new word onto the Data Bus (DB0 through DB3) and then issues an Out strobe.

3-42. Mode Switch PCB Assembly

3-43. The Mode Switch PCB Assembly, as shown in Figure 3-6, operates as a controller peripheral and is capable of both

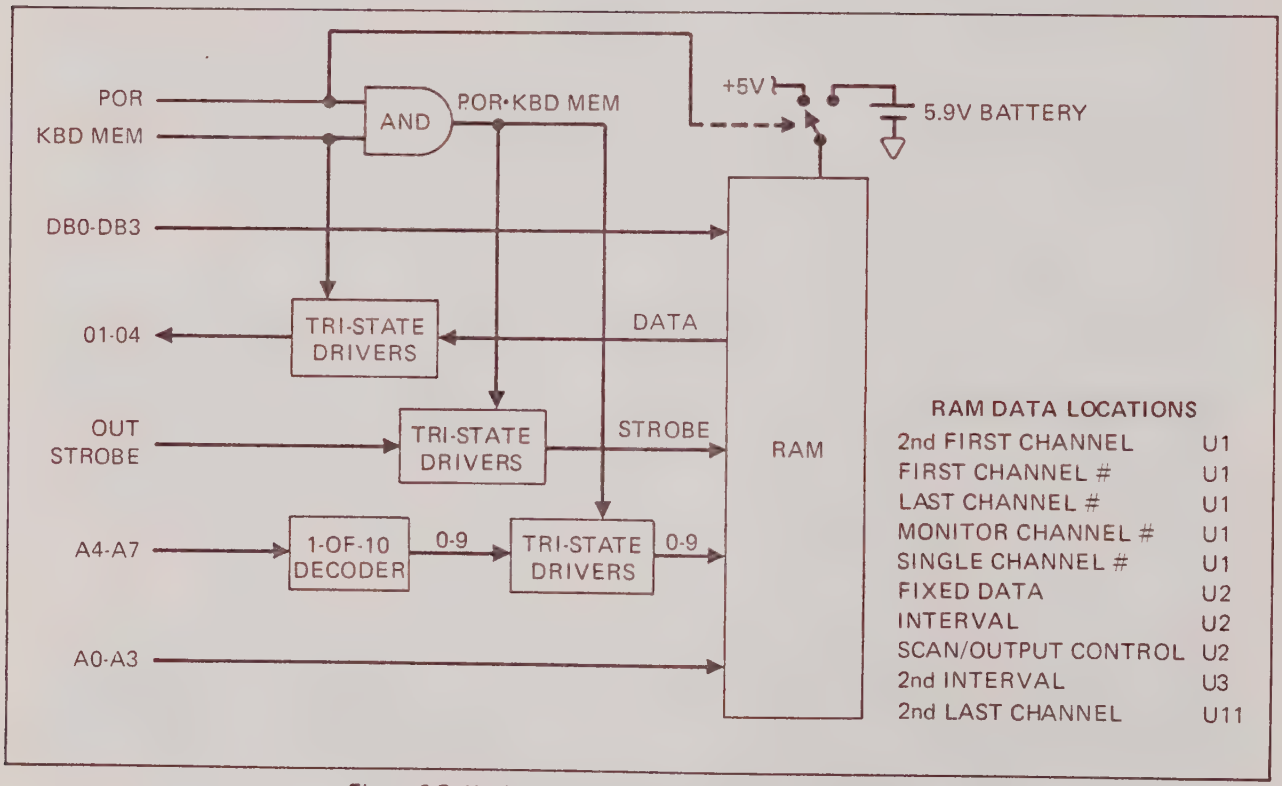


Figure 3-5. Keyboard Memory, Simplified Block Diagram

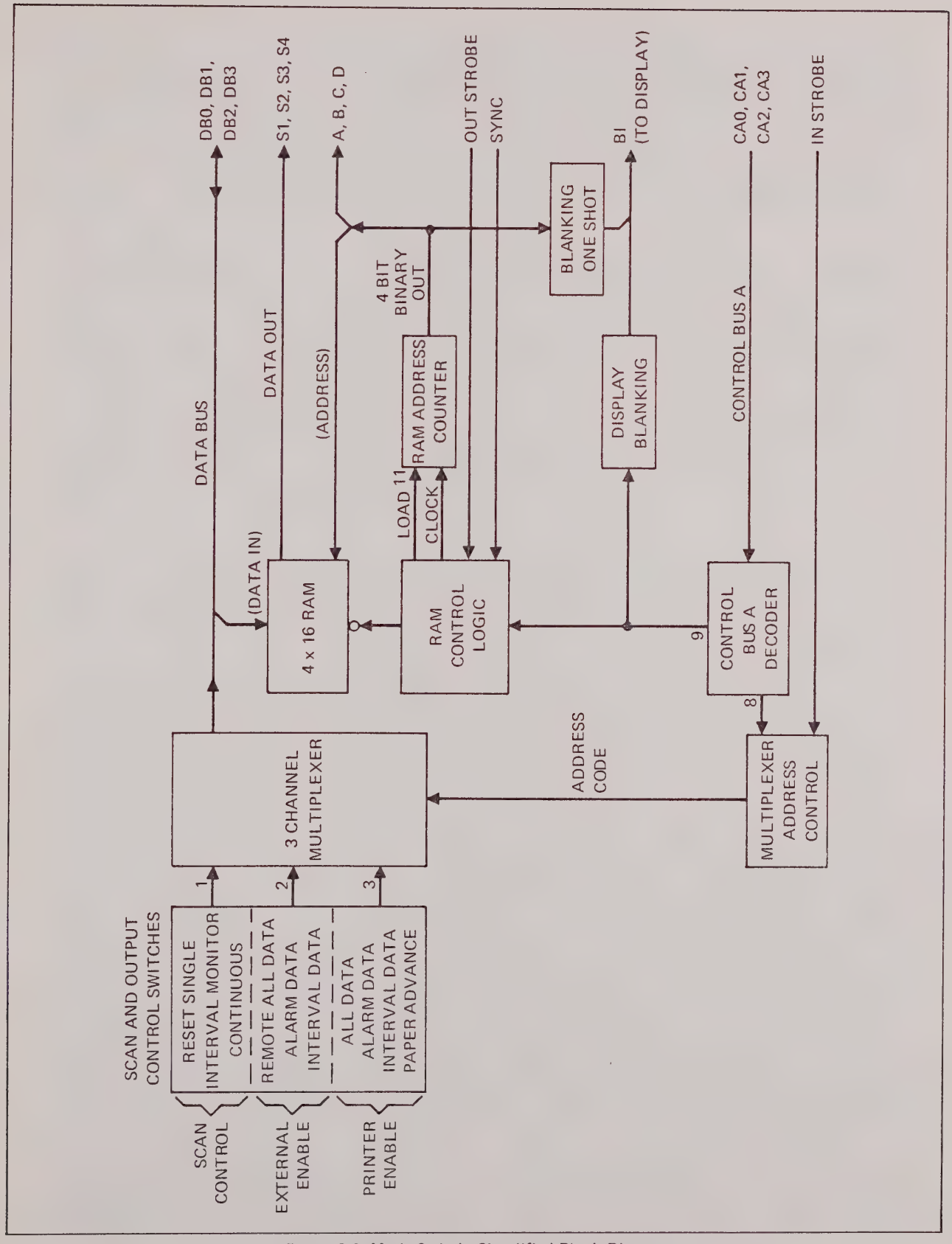


Figure 3-6. Mode Switch, Simplified Block Diagram

transmitting and receiving data via the Data Bus. In the transmit mode, it provides the controller with SCAN CONTROL and OUTPUT CONTROL switch-setting information. In the receive mode it accepts and stores numeric decade information from the controller for use in driving the front panel display. The required operating mode is enabled via address data placed on Control Bus A and is executed under the direction of control signals received from the controller.

3-44. In the transmit mode of operation the Mode Switch PCB Assembly scans the individual settings of the SCAN CONTROL and OUTPUT CONTROL switches and places the position information (depressed or out) onto the Data Bus for use by the controller. Transmit mode operation begins when the controller places a binary coded 8 on Control Bus A. This code is detected by the Control Bus Decoder on the Mode Switch PCB and is used to enable a 3-bit Multiplexer Address Control counter. The counter is sequenced by subsequent In strobe pulses from the controller, and is used to sequentially address each channel of a three channel (4-bit per channel) multiplexer. Each channel of multiplexed data contains the switch position information for 4 of the 12 CONTROL switch settings. This data is presented to the Data Bus on the leading edge of the In strobe, and is assimilated by the controller on the trailing edge. At the end of the third In stobe all 12 CONTROL switch settings have been transmitted and the controller removes the address code from Control Bus A. This isolates the Mode Switch PCB from the Data Bus and, thus, the controller.

3-45. In the receive mode of operation the Mode Switch PCB receives updated display information from the controller (via the Data Bus) and stores it in a 4 x 16 bit RAM. Receive mode operation begins when the controller places a binary coded 9 code on Control Bus A. As a direct result of the address code, the RAM address counter is preset to binary coded 11 output (via the RAM control logic) and the front panel display is blanked by a high BI level generated by the display blanking circuit. On the trailing edge of the next Sync pulse the RAM control logic is conditioned to respond to the controller generated Out strobe. A valid display character precedes each Out strobe and is placed on the Data Bus by the controller. On the leading edge of the first Out strobe the RAMs write enable input is pulled low and the Data Bus character is entered into the binary coded 11 RAM location as defined by the RAM address counter. On the trailing edge of the Out strobe the counter is decremented to 10 and new data is solicited from the controller. The remaining 11 characters are similarly written into memory by the controller. After all 12 characters of display data have been written, the controller terminates the receive mode by removing the binary coded 9 code from Control Bus A.

3-46. When the Mode Switch PCB is not operating in the receive mode the sync pulse causes the RAM control logic to continuously cycle and, thereby address the RAM locations. As each location is

addressed, its stored 4-bit character is presented to the display PCB via data output lines S1, S2, S3, and S4. Since the RAM does not output data via the Data Bus, transmit and RAM read operation are conducted simultaneously. However, receive and RAM read are mutually exclusive operations.

3-47. A blanking one-shot is used to blank the display if the counter stops running. This prevents the display segments (which are normally scanned) from drawing excessive current in a static situation.

3-48. Display PCB Assembly

3-49. The Display PCB Assembly, as shown in Figure 3-7, operates as an extension of the Mode Switch PCB Assembly. It provides a digital display of either date and time, measurement, or program data that has been processed by the controller, and stored in the 4 x 16 bit RAM on the Mode Switch PCB Assembly. As the RAM locations are serially addressed and read, both the address and the stored data readings are presented to the Display PCB. Address data is received as inputs A, B, C, and D. Stored data is received as inputs S1, S2, S3, and S4.

3-50. The individual display digits are formed by nine 7-segment LEDs. These LED's are driven in parallel by the output of a BCD-to-seven segment decoder whose input is taken directly from the mode switch as S1, S2, S3, and S4. Each of the LEDs is individually strobed in serial fashion, and allowed to respond to data present on the seven-line Data Bus. The strobe sequence is derived directly from the mode switch RAM address counter (A, B, C, D), and each strobed LED is allowed to read the addressed character stored in the (Mode Switch PCBs) corresponding RAM location. Since the data is scanned very rapidly (sync pulse frequency (-12), the display character appears to be continuously lit.

3-51. In addition to the nine numeric characters, the Data Display PCB also contains provisions for driving the polarity (minus only), annunciator (MILLIVOLTS, VOLTS, TEMPERATURE, and DATE AND TIME), and decimal point LEDs as stored in the RAM on the Mode Switch PCB. Annunciator data is read from the seven-line Data Bus as if it were a numeric character. However, polarity and decimal point data are not. When either of these two RAM locations are addressed (binary coded 9 or 11) the resultant strobe (from display column decoder) disables the BCD-to-seven segment decoder and enables the decimal point position decoder. Under these conditions the seven-line Data Bus is dead and data from the addressed RAM location is decoded by the decimal point position decoder. The appropriate decimal point location(s) and/or minus polarity LEDs are driven by the output of the decimal point position decoder. Table 3-2 lists each of the display strobe lines decoded from the RAM address counter on the Mode Switch PCB, and indicates the data enabled during each display (strobe) period.

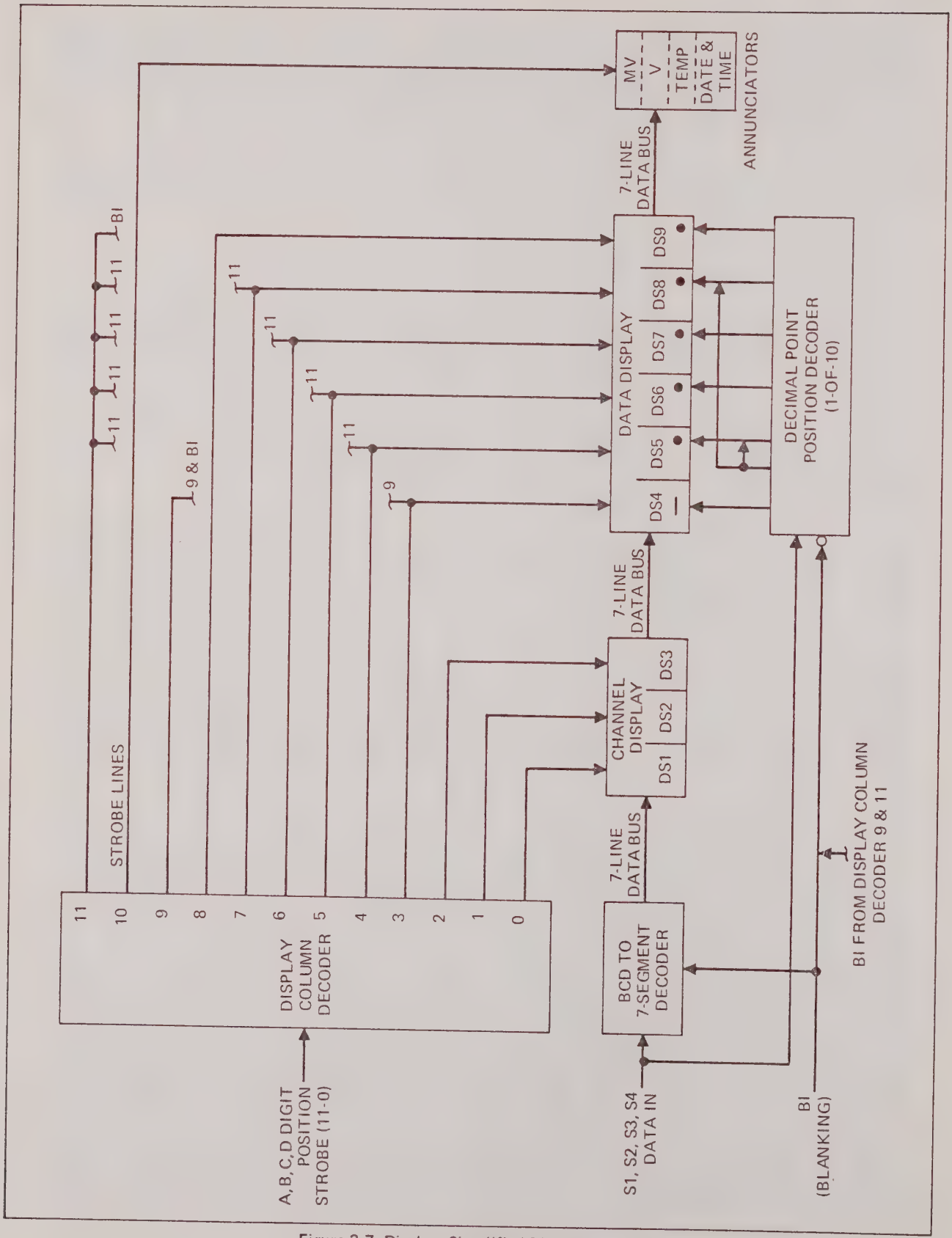


Figure 3-7. Display, Simplified Block Diagram

Table 3-2. Display LED Addresses and Functions

STROBE CODE	LED ENABLE	LED FUNCTION	
11_2	DS5, DS6, DS7, DS8	DECIMAL POINTS	
10_2	CR18, CR19 CR20, CR21	ANNUNCIATORS	
9_2	DS4	MINUS SIGN	
8_2	DS9	LSD	DATA DISPLAY
7_2	DS8	5TH DIGIT	
6_2	DS7	4TH DIGIT	
5_2	DS6	3RD DIGIT	
4_2	DS5	2ND DIGIT	
3_2	DS4	MSD	
2_2	DS3	LSD	CHANNEL DISPLAY
1_2	DS2	2ND DIGIT	
0_2	DS1	MSD	

3-52. Printer Drive PCB Assembly

3-53. The Printer Drive PCB Assembly, as shown in Figure 3-8, operates as a controller peripheral, to interface the internal Seiko Model 102 printhead with the controller Data Bus. Both transmit and receive operating modes are employed in the printing operation. The transmit mode is used to solicit data from the controller and to synchronize the controller to the printers mechanical rotation. In the receive mode the controller sends printer data to the Printer Drive PCB Assembly via the Data Bus. Data for all 16 columns is printed within the time required for one rotation of the printer drum.

3-54. The printer is a free-running device and (to print properly) requires that input data be synchronized with the mechanical rotation of its print drum. Print drum position information is generated by the printhead in the form of a Reset pulse and a series of 13 TL-TP pulses. Reset is generated once for every print drum revolution and indicates that row 0 is positioned under the 16-column print hammers. TL-TP pulses are generated as each of the 13 possible data rows (0 through 12) are positioned beneath the print hammers. Therefore, for each print drum revolution, 1 Reset pulse is generated and 13 TL-TP pulses are generated.

3-55. The TL-TP pulses from the printer are used by the Printer Drive PCB to synchronize the system clock (Sync) with the printer's drum position. Since the sync pulse frequency is much higher than the TL-TP frequency, synchronization is accomplished by a coincidence detector and does not require a change in the drum rotation or system clock frequency. When either a Reset or a TL-TP pulse is detected, a pulse is generated by the synchronizing logic. This pulse arms the interrupt control logic to enable the next Sync pulse to generate an Interrupt to the controller and, thereby indicate that the printer's drum is in position to receive data.

3-56. In response to the Interrupt, the controller interrogates the status of the three possible interrupt peripherals to determine which generated the Interrupt signal. When the Printer Drive status is requested (by a binary coded 13 on Control Bus A) it responds by placing the Reset and TL-TP signal levels onto the Data Bus (via status response logic) as bits DB2 and DB3, respectively, thus confirming that it initiated the Interrupt. When the controller generates the next In strobe, it reads the confirming interrupt status code (binary coded 12) and then removes the status interrogation code from Control Bus A. As the status request line from the control bus decoder goes low it resets the interrupt control logic and returns the Interrupt to a high level.

3-57. If the controller is ready to supply data to the Printer Drive PCB when the Interrupt line returns high, it places a

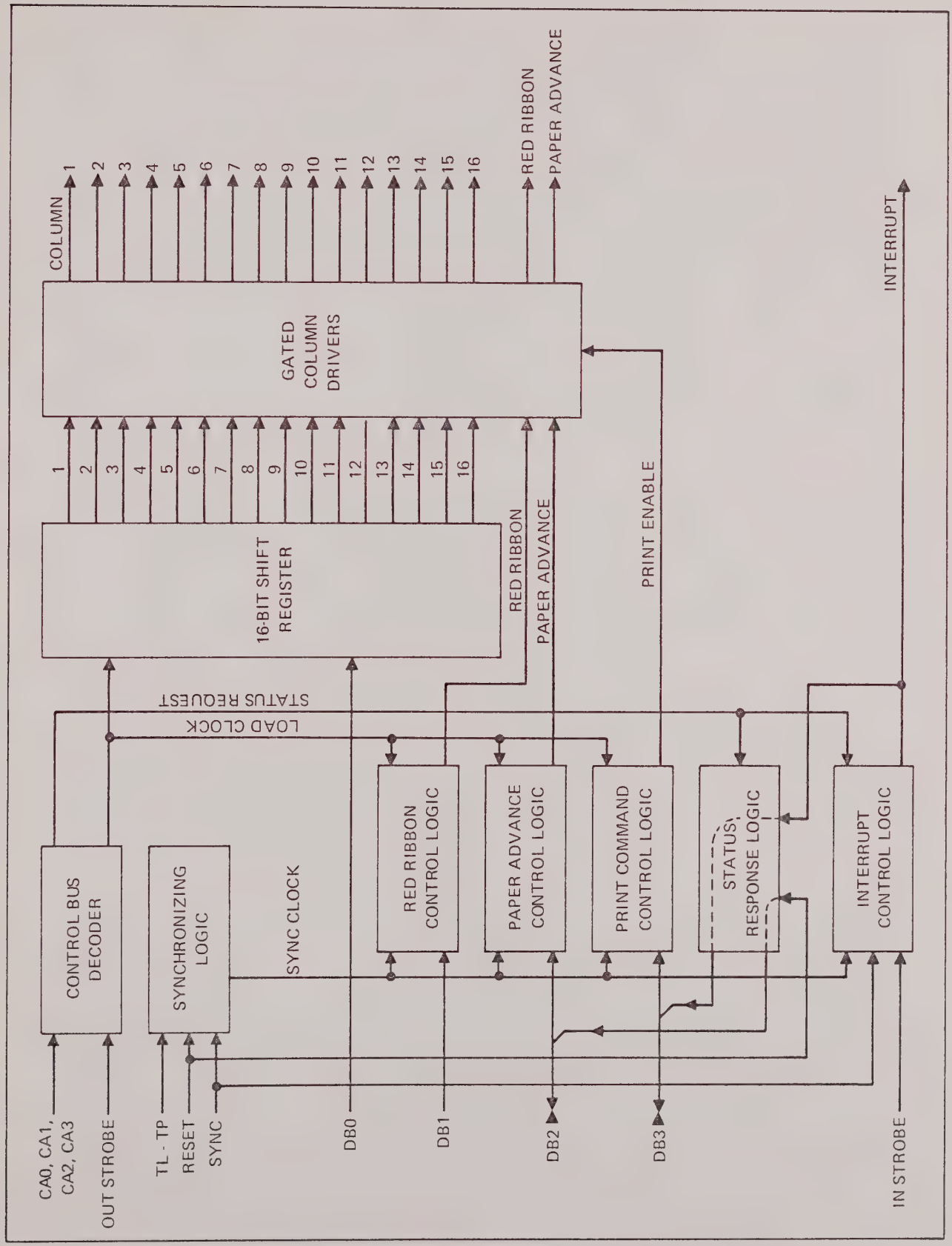


Figure 3-8. Printer Drive, Simplified Block Diagram

binary coded 5 onto Control Bus A. The control bus decoder detects this code and enables the 16 subsequent Out strobes from the controller to be accepted as a series of 16 Load clocks on the Printer Drive Assembly. As each Load clock is accepted, the bit-serial data on DB0 is loaded into a 16-bit shift register. This stored data determines which print hammers, if any, will be activated while row 0 of the printer drum is under the print hammers. As the 16th data bit is presented to the shift register, Red Ribbon, Paper Advance, and Print Command data are received on DB1, DB2, and DB3, respectively. The subsequent Load clock shifts the last data bit into the 16-bit shift register, enters ribbon color data into the red ribbon control logic, and enters paper advance information into the paper advance control logic. On the trailing edge of the Load clock the print command control logic generates a Print Enable signal. This signal enables the gated column drivers (tri-State drivers) to energize the appropriate print hammers and, thereby print row 0 characters in the selected columns. The printer also responds to the red ribbon and paper advance commands, when present.

3-58. As the print drum continues to rotate, row 1 data is loaded into the shift register and the appropriate print hammers are energized. The sequence is performed a total of 13 times (once for each row on the printer drum) to complete a single print sequence. After the 13th Print Enable is derived from the Out strobe, the controller terminates the sequence by removing the printer receive code (binary coded 5) from Control Bus A.

3-59. Power Supply PCB Assembly

3-60. The Power Supply PCB Assembly, as shown in Figure 3-9, provides the operating voltages for the data logger and a full complement of options. It also provides the 1-second time interval marker (TIM) and the Power-On-Reset (POR) signal. TIM is used by the controller to update date and time. POR is used to initialize the entire data logger when power is turned on or when a power interruption occurs.

3-61. Input power for the power supply is derived from a 115/230V ac power transformer with four secondary windings. Transformer line power requirements (115/230V ac) are switch selectable through a switch mounted on the Power Supply PCB. Output windings are separated into two pairs by a transformer shield. Isolation between the pairs is maintained on both the Power Supply PCB and the data logger by including the shield as part of the data logger's guard circuit. As a result the data logger's operating voltages are classified as guarded and unguarded. Guarded voltages include +21 and -21V dc unregulated, and +5V dc regulated. Unguarded supplies include +5V dc, +16V dc, and -10V dc; all of which are regulated and overload protected. The 1-second time base circuitry and the Power-On-Reset circuit are contained in the unguarded section of the power supply.

3-62. Conventional regulating techniques are used in both

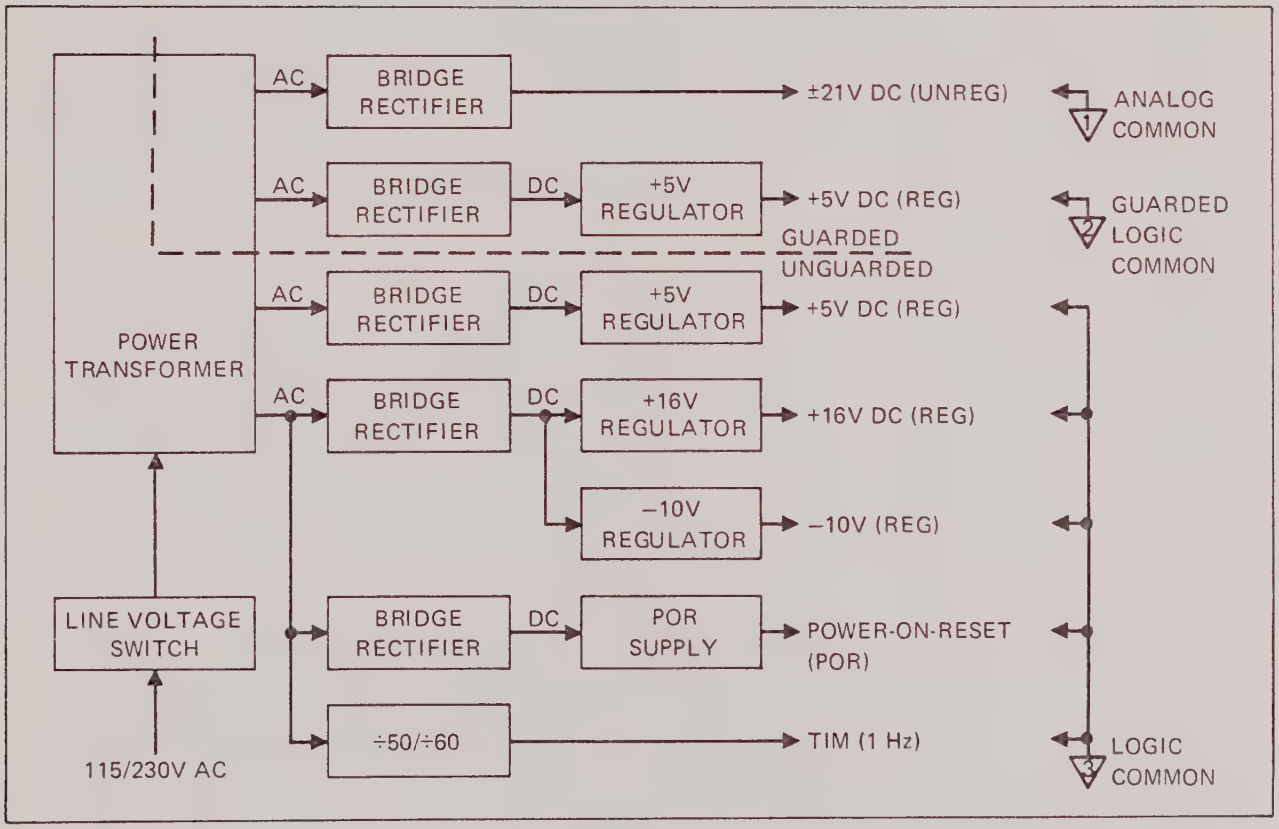


Figure 3-9. Power Supply, Simplified Block Diagram

sections of the power supply. No voltage adjustments are required or included in the guarded section of the supply. In the unguarded section the -10V dc output serves as a reference voltage for both the +5 and +16V dc regulators. As a result, a single adjustment is provided for the -10V dc supply. When the -10V dc is calibrated the +5 and +16V dc supplies are automatically calibrated.

3-63. The 1-second time marker circuit consists of a switch selectable divide-by-50 or divide-by-60 IC whose input clock is derived from the ac voltage present at one of the transformer's secondary windings. When the IC is set to divide by the actual line frequency (50 or 60 Hz) it generates a 1 Hz pulse as an output. The pulse is buffered and provided as a power supply output signal (TIM) for use by the controller for updating date and time entries.

3-64. The Power-On-Reset (POR) signal serves as a reset command to initialize the system when power is initially turned-on, or when line power is restored after a power failure. POR is generated by a fast-acting unregulated supply whose output is normally low during power off. When line power is initially applied, POR remains low for approximately 600 ms (reset period) and then goes high (+5V dc). The signal is adequately buffered for use in resetting all data logger logic.

3-65. Range and Function Memory PCB Assembly

3-66. The Range and Function Memory is a nonvolatile memory peripheral for the controller. Channel function data, limits data, mx+b scaling data, and temperature function data are stored in the Range and Function Memory PCB if the limits, scaling, or temperature option is installed. Data entered through the keyboard or through a Remote Programming Option is stored in the Range and Function Memory PCB.

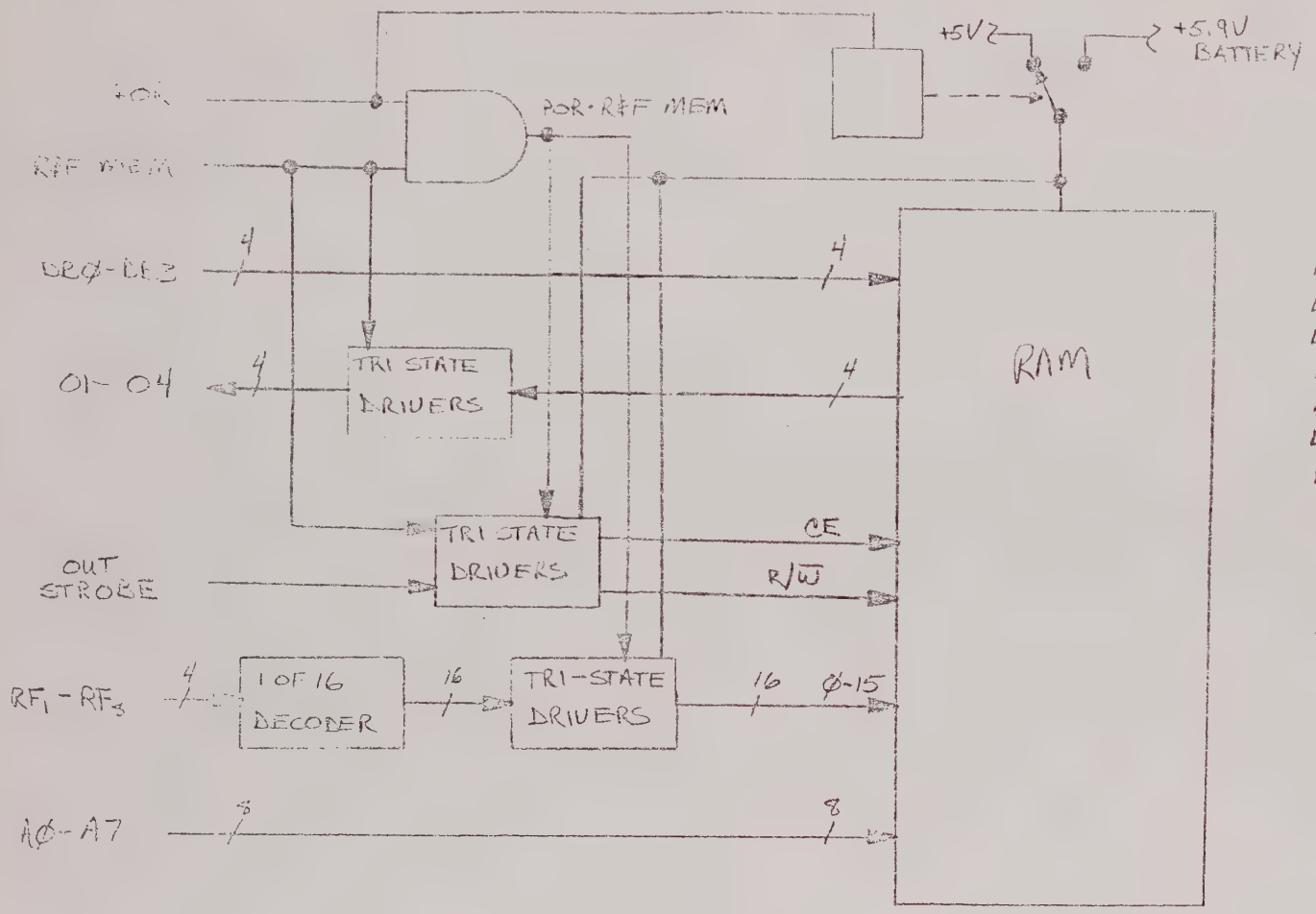
3-67. The simplified block diagram in Figure 3-10 identifies the functional logic contained on the Range and Function Memory PCB Assembly. It also defines the major data flow to, from, and within the pcb. Prior to initial turn-on, previously entered program data is sorted in a series of RAMs, on it is maintained by a 5.9V lithium battery. The battery is switched into the circuit during the absence of the Power-On-Reset (POR) signal (high during power-on) as derived from the Power Supply PCB. When power is turned on, the RAM memory is switched to operate from the unguarded +5V dc (line powered) power supply.

3-68. Memory is enabled for either read or write applications when both the Power-On-Reset signal from the power supply and the Range and Function Memory (R&F MEM) signal from the Controller are present as Range and Function Memory inputs. These signals are ANDed to enable a series of tri-state drivers which normally isolate the RAM and prevent it from being read or written into.

2240C

Range & Function Memory Block Diagram

15-Oct-8
D. Wilbra



RAM DATA LOCATIONS

FUNCTION CH Ø-255	U19
LIMIT A ADDRESSES	U20
LIMIT B ADDRESSES	U21
LIMIT C ADDRESSES	U22
LIMIT D ADDRESSES	U23
LIMIT VALUES 1-60	U18
Mx+b LIMIT DATA	U17
Mx+b ADDRESSES	U16
Mx+b 'm' Values	U8
Mx+b 'b' Values + Decimal Point	U9

Temperature Function U

FIGURE 3-10 RANGE AND FUNCTION MEMORY PCB BLOCK DIAGRAM

3-69. After memory is enabled, read or write operations can be executed in a character-serial fashion. An eight-bit address bus, A0 through A7, is operated by the Controller and used to select a particular location within the RAMs. A four-bit memory select bus (RF1, RF2, RF4, and RF8) drives a 1-of-16 decoder to develop the individual IC memory address, while the eight-bit address bus defines the character (word) within the addressed memory IC.

3-70. Data present in the addressed memory location is placed on the Output Bus (01 through 04) and, if desired, can be read by the controller. If a word is to be written into the location addressed, the controller places the new word on the Data Bus (DB0 through DB3), then issues an Out Strobe.

3-71 Guard Crossing PCB Assembly

3-72. The Guard Crossing PCB Assembly operates in conjuction with the High Performance A/D Converter to provide the data logger with guarded, programmable, A/D voltage-measurement capability. Functions performed by the Guard Crossing PCB in this operation include: electrical isolation of the guarded input section of the data logger from the unguarded digital control section, and digital control for the analog half of the dual-slope A/D converter (i.e., A/D control logic, crystal controlled clock, and main counter string). The theory of operation given herein describes the isolation and digital I/O functions performed by the Guard Crossing PCB Assembly, but does not include the theory of operation for the dual-slope a/d conversion process.

3-73. The Guard Crossing PCB Assembly, as shown in Figure 3-11, operates as a Controller peripheral and is capable of both receiving and transmitting data via the Data Bus. In the receive mode, channel and range programming data is accepted from the Controller, transferred across the guard crossing, and presented to the a/d converter. In the transmit mode, status or measurement data from the digital section of the a/d converter is transferred across the guard and presented to the Controller. The required operating mode is enabled when the appropriate address code is present on Control Bus A, and is executed under the direction of control signals received from the Controller.

3-74. The receive mode is enabled when the Controller places a binary coded 2 on Control Bus A. Input data from the Controller is received in character-serial format (four 4-bit characters) on the Data Bus (DB0 through DB3) and temporarily entered into storage in the channel and range latch by the Out Stobe. Once stored, the character is optically transmitted across the guard, buffered, and presented to the a/d converter as channel and range ocntrol data. As each character crosses the guard, it is followed by a 10 us Receive clock. The clock is derived from the Out strobe and is generated by the receive clock logic. On the guarded side of the pcb, the Receive clock increments a four-bit shift register, the output of which addresses range (S1) and

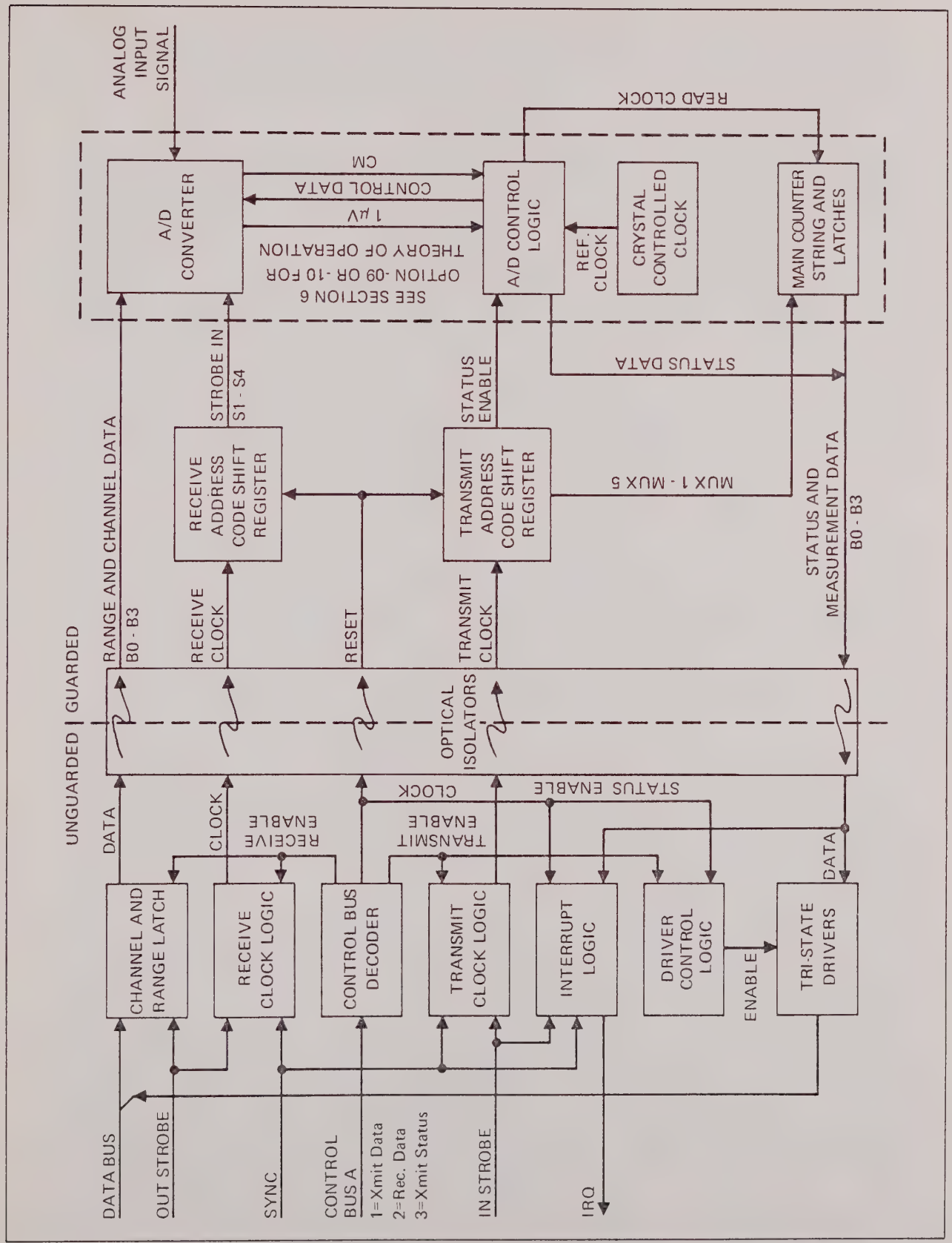


Figure 3-11. Guard Crossing, Simplified Block Diagram

channel storage (S2, S3 and S4) locations on the a/d converter option. Data entered into these locations define the channel to be measured and the measurement range to be used.

3-75. The transmit status mode is enabled when the Controller places a binary coded 3 on Control Bus A. During the presence of this code, the control bus decoder generates a Status Enable signal which is used to perform three separate functions. First, it is transmitted across the guard where it is used to reset (initialize) both the transmit and receive address code shift registers. Second, it enables the tri-state driver switch allow transmitted data to be placed onto the Data Bus. Third, it allows the next In strobe to reset the Interrrupt Logic and, thereby, clear the interruupt request line (IRQ).

3-76. When the tri-state drivers are enabled and the two address code registers are reset, status information is allowed to appear on the Data Bus as a single four-bit output character. Three separate characters are employed to indicate each of the following status conditions: measurement data ready, new channel and function data required for next measurement, and 1 uV signal. All three of these codes are derived from the a/d control logic portion of the Guard Crossing. The new-data-required and data-ready status conditions are keyed to the beginning and end, respectively, of each measurement cycle. The 1 uV signal is transmitted only once (during the initial power-on) and is used to inform the Controller of the type of A/D Converter installed.

3-77. When the a/d converter completes a measurement cycle it notifies the Controller by setting the Interrupt Logic and pulling the IRQ line low. The Controller responds by serially interrogating the status of the Printer Drive, the output options, and the Guard Crossing PCB Assemblies, to determine which of the three random responding units pulled the IRQ line low. When the Guard Crossing PCB is interrogated, it indicates that the measurement data is ready to be transmitted. The Controller responds by terminating the status transmit mode and enabling the transmit data mode.

3-78. The transmit data mode is enabled when the Controller places a binary coded 1 code on Control Bus A. While the code is present on the Control Bus, it causes the control bus decoder to generate a transmit Enable signal. This signal, in turn, enables the tri-state drivers and the transmit clock logic. The next In strobe from the Controller is passed through the transmit clock logic, coupled acrosss the guard and used to set the first position of a five-bit shift register. Each subsequent In strobe is used to advance the shift register position and, thereby, sequentially address a five-channel multiplexer (main counter string and latches) in which measurement data is stored (MUX1-MUX5). As each channel of data is addressed (LSD first, MSD last), it is placed onto the guarded side of the data bus (B0 through B3), transmitted across the guard, and presented to the Data Bus through the enabled tri-state drivers. Each character is

read into the Controller on the trailing edge of the In strobe.

3-79. A/D Converter

3-80. The High Performance A/D Converter PCB operates in conjunction with the Guard Crossing PCB to perform the analog functions of a five range (40 V, 4 V, 400 mV, 80 mV, and 40 mV), dual slope, integrating DVM capable of resolving 1 uV on the 40 mV range. Digital program and control data necessary to complete a measurement cycle (this includes the read clock) are generated on the Guard Crossing PCB. Similarly, a 40,000 count counter string is included on the Guard Crossing PCB for accmulating the digital equivalent of the measured analog input. After measurement data is accumulated, it is presented to the Data bus in character-serial format when solicited by the controller. A simplified block diagram of the High Performance A/D Converter plus the associated digital logic from the Guard Crossing is given in Figure 3-12. A detailed schematic of the High Performance A/D Converter PCB Assembly is available in Section 8.

3-81. Digital Control Logic

3-82. Digital control logic for the High Performance A/D Converter is contained on both the Guard Crossing PCB and the A/D Converter PCB. A/D conversion logic on the Guard Crossing PCB consists of a two-speed crystal controlled clock, a digital counter with latches and multiplexed tri-state outputs, and dual-slope digital control logic. Digital logic on the High Performance A/D Converter PCB consists of four addressable 4-bit registers and three output decoders. All digital input data utilized by the digital control logic is received from the controller via the Guard Crossing PCB Assembly.

3-83. Operation of the guard crossing logic is synchronized with the output of the crystal controlled clock, which is divided down so that integrate time is an even multiple of a line cycle to optimize the common mode and normal mode rejection characteristics of the A/D Converter. This is accomplished by installing either a 2 MHz or 2.4 MHz crystal for 50 to 60 Hz line frequencies, respectively. Additional clock circuitry in the form of pulse shaping dividers produce the final 2-phase reference clock as received by the dual-slope control logic.

3-84. Clock rate (and, therefore, measurement speed) can be selected manually by positioning a FAST/SLOW slide switch on the A/D Converter PCB. In the fast position a 1.2 MHz (60 Hz), 2-phase clock is supplied directly to the A/D Converter logic. Since a measurement cycle requires 80,000 clock pulses to produce a reading, the A/D converter can accomplish a maximum of 15 readings per second. In the slow switch position the 1.2 MHz clock is divided by five. Thus, the measurement rate is reduced to three readings per second, maximum.

3-85. Overall timing of the dual-slope conversion process is

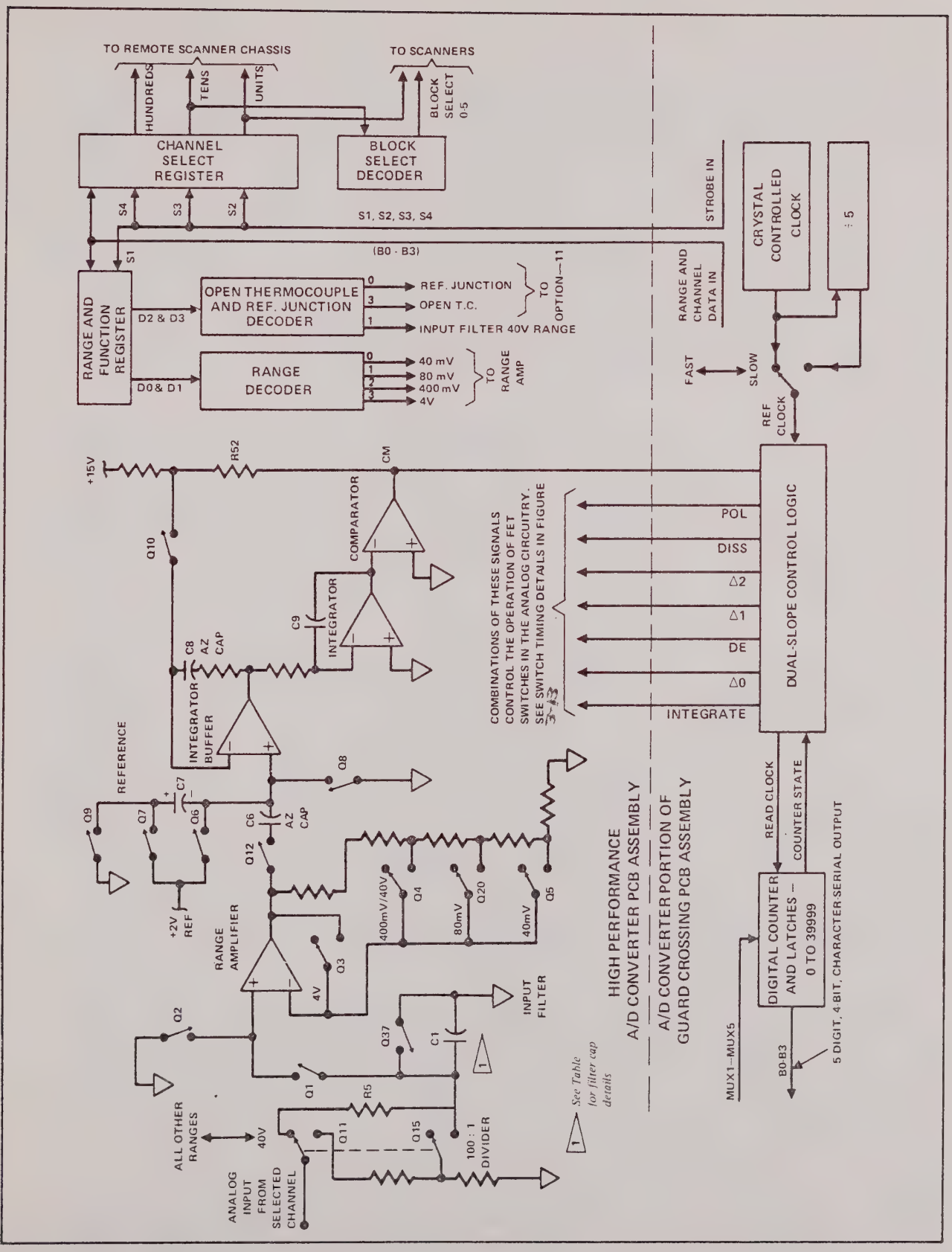


Figure 3-12. General Purpose A/D Converter PCB Assembly Functional Block Diagram

governed directly by the dual-slope control logic. Two control flip-flops (U14B/FAA and U20A/FFB) operate in response to the carry outputs of the various counter stages and the reference clock to determine the next state of the dual-slope control logic and, therefore, its output control signals. These signals are shown in Figure 3-13 and described in Table 3-3.

3-86. The data accumulated in the digital counter (if ≤39999) is determined to be the digital equivalent of the analog input voltage when the CM (compare) input from the A/D Converter PCB transistions to a state which is the opposite of the POL (Polarity) level. This transition indicates the end of the read period and causes the counter data to be loaded into the output latches. It also initiates a Data Ready signal which is transmitted across the guard as part of the status word.

3-87. When the controller detects the Data Ready status it generates a series of five Strobe In pulses which are converted on the Guard Crossing PCB into a series of five multiplexer pulses, MUX1 through MUX5. As each pulse sequentially occurs, one of the five 4-bit counter characters is solicited, transferred across the guard before the next measurement cycle is allowed to start (i.e., the reference clock is inhibited until MUX5 goes low to indicate that the last digit of measurement data has been solicited).

3-88. Channel select data for measurement purposes is updated once during each A/D conversion (measurement) cycle so that new analog data can be presented to the A/D converter. Updating occurs in response to an interrupt status signal generated by the Guard Crossing PCB. The interrupt causes the controller to specify the next programmed measurement channel and its associated function data to the Guard Crossing PCB. Data is received as a series of four 4-bit characters which are serially transferred across the guard to the A/D Converter PCB. A unique strobe pulse (S1 through S4) accompanies each character and causes it to be entered into a 4-bit register. The first character is entered into a range and function register by strobe pulse S1. The second, third, and fourth characters are similarly entered into a series of three channel select registers by strobe pulses S2, S3, and S4, respectively.

3-89. Range and function data for the next measurement cycle are derived from the first stored character. Its two low-order bits, D0 and D1, are decoded to provide the range command (4V, 400 mV, 80 mV, 40 mV) for the Range Amplifier on the A/D Converter PCB. Similarly, the 40V range, open-thermocouple detect and reference-junction measure commands are decoded from the two high-order bits, D2 and D3.

3-90. Channel select commands (units, tens, and hundreds) are taken directly from the output of the three channel select registers. Tens data is decoded to provide the individual block select commands for the first 60 (0-59) channels in the data

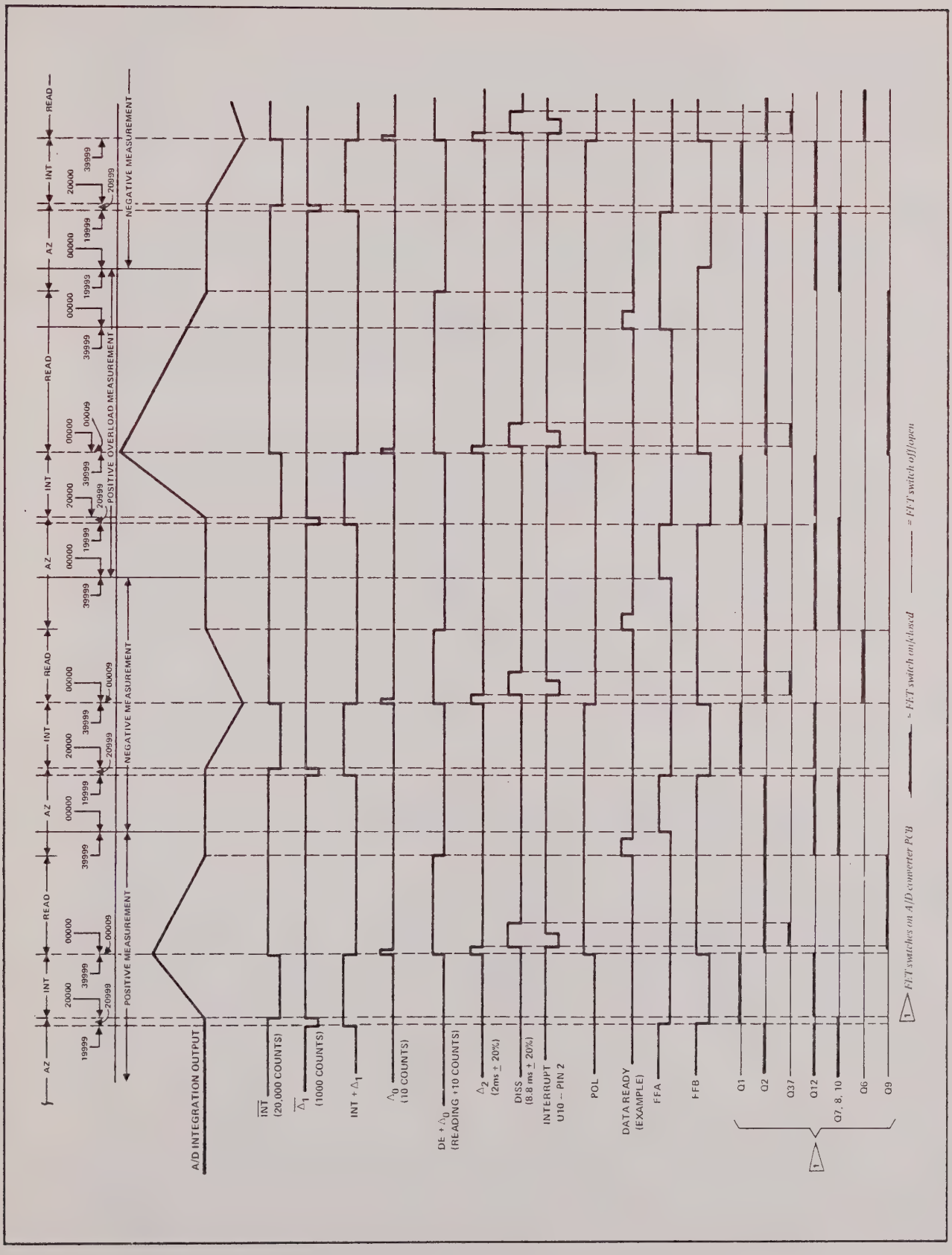


Figure 3-13 A/D Converter Timing Diagram

Table 3-3. Guard Crossing Signal Descriptions

SIGNAL NAME	DESCRIPTION
Int +△1	A 21000 count period derived directly from control flip-flop FFB (U20A). Used for controlling FET switching on the A/D Converter PCB.
△1	A 1000 count period which starts when FAA and FFB are both low and the counter has reached a count of 19999. The period ends when the counter three least-significant stages go through a count of 999. At this time the fourth stage is prevented from clocking so that the clock pulse will change the counter from 20999 to 20000. This signals the beginning of the integrate period.
△0	A 10 count period immediately following the end of the integrate period. During this time the second counter stage is inhibited so that the count goes from 39999 to 00009 and then to 00000. Thus, after a 10 count settling period the read period starts at a count of 00000 and continues on. The count at the end of the read period is proportional to the analog input voltage.
POL	Indicates the polarity of the integrated input signal, and is derived from the level (high or low) of the CM signal at the end of the integrate period.
△2	A 2 ms pulse generated at the end of the integrate period. It is used by the Temperature and Scaling Option —11 to trigger and open thermocouple detector.
Diss	An 8.8 ms pulse generated at the end of △2. It is used to discharge the input filter before the next analog input is applied and to prevent the closing of more than 1 scanner relay at a time.
DE	A variable length read period which begins at the end of the △0 pulse. The end of the read period occurs when the CM pulse transitions to a state that is different from POL or when the counter counts through 19999 after an overload reading of 39999.
Ł (Overload)	An overload signal (1-bit) which is returned to the controller with the MSD of measurement data. The signal occurs when the counter counts through 39999 before a CM input transition occurs, and prevents the counter MSD from going from 19999 to 20000. Instead, the counter transitions from 19999 to 00000. This allows an extra 20000 count auto-zero period to ensure full recovery from the overload condition.

logger, while units data activates the appropriate channel relay (0-9) in the selected scanner block-channel commands above 59 (60 through 999) are available at a rear-panel connector on the A/D Converter PCB for use in selecting channels maintained in an external scanner chassis (220A1, 2202A, and/or 2203A).

3-91. Analog Circuit

3-92. The analog portion of the dual-slope A/D converter is contained entirely on the High Performance A/D Converter PCB Assembly. It consists of an input filter, a range amplifier, a reference supply, an integrator buffer, a comparator, and a series of FET switches. Digital control signals from the Guard Crossing PCB control the operation of the analog circuit. Figure 3-13 relates the operation of each individual FET switch to the digitally controlled measurement cycle.

3-93. Operation of any given measurement cycle can be logically divided into three measurement periods: auto zero, integrate, and read. Auto zero is used to measure and eliminate any in-circuit errors which might influence the end reading. Integrate allows the input signal is sampled (integrated) for a known time period. During the read period two separate functions are performed. The next analog input is applied to the input (integrate), and input voltage is compared (integrated) against a reference voltage. The time required to complete the read period is then translated, by the dual-slope control logic, into a digital equivalent of the analog input voltage.

3-94. The auto zero period beings at the end of the read period, as indicated by the leading edge of the Data Ready pulse. At that time, FET switches Q1, Q37, Q6, and Q9 are open and Q2, Q7, Q8, Q10, and Q12 are closed. Switch Q1 isolates the input of the range amplifier from the analog level present at the input filter. Switches Q2 and Q8 provide zero volt reference levels for charging a series of reference capacitors C6, C7, and C8. Capacitor C6 charges through Q8 and Q12, to a value which is equal to the offset voltage error inherent in the range amplifier. Similarly, capacitor C8 is charged through switch Q10 to a value which is equal to the loop offset voltage of the integrator buffer, integrator and comparator combination. Finally, capacitor C7 is charged to the +2V reference level through switches Q7 and Q8. The charges on these capacitors will be retained throughout the remainder of the measurement cycle for use in eliminating offset errors (C6 and C8), and providing the choice of selectable reference polarity (C7) which is compatible with the analog input signal.

3-95. Termination of the auto zero period occurs in two steps. First, switches Q2 and Q12 are opened and switch Q1 is closed. This isolates the range amplifier output from the rest of the circuit and allows it to respond to the input voltage applied through switch Q1. Second, switches Q7, Q8, and Q10 are opened and switch Q12 is closed. This connects the output of the range

amplifier to the integrator buffer. At this time, the auto zero period is ended and the integrate period begins.

3-96. During the integrate period the integrator buffer presents the integrator with an offset corrected dc input voltage which is equivalent to the analog input voltage level. This signal is then integrated for a fixed time which is equal to 20,000 read-clock pulses, as determined by the digital counters on the Guard Crossing PCB. When the time period is satisfied the integrate period is ended and the read period is started.

3-97. At the start of the read period, switches Q1 and Q12 are opened, and Q2 and either Q6 or Q9, are closed. Switches Q1, Q2, and Q12 electrically remove the range amplifier and, therefore, the analog input signal from the input of the integrator buffer. If the input signal was positive, switch Q9 is closed and a -2 volt reference is applied to the integrator buffer via the previously charged reference capacitor C7. However, if the original analog input signal was negative, switch Q6 is closed causing the +2 volt reference to be applied directly to the input of the integrator buffer. In either event, integrator capacitor C9 begins to discharge at a fixed linear rate, and the counter string on the Guard Crossing PCB begins to count and accumulate the reference clock output. The discharge continues until the capacitor reaches clock output. The discharge continues until the capacitor reaches a zero-charge level as determined by the previous auto-zero period. When that level is detected by the comparator, a compare (CM) transition is generated to terminate the read period. This stops the counter on the Guard Crossing PCB and returns the analog circuitry to the auto-zero period. (The next measurement cycle starts after data is transferred across the guard to the controller).

3-98. Since the range amplifier and the input filter are isolated from the rest of the analog circuit at the beginning of the read period, both digital range data and the analog input signal for the next measurement channel are entered at that time. This allows both the input filter and the range amplifier to settle before the next measurement cycle begins.

3-99. The input filter is a single pole RC filter designed to suppress noise which accompanies the input signal. On all ranges, except 40V, resistor R5 acts as the primary resistive component. The capacitive component, however, varies as a function of both measurement speed (fast/slow) and selected range. On the 40V range, resistor R5 is switched out of the input circuit by relay, K1, and is replaced by a 100:1 divider. On the 40 mV and 80 mV ranges separate capacitors, as well as active clamp circuitry (U25), are switched into the circuit. Table 3-4 defines each of the input filter capacitors, as well as which capacitor (s) is (are) selected for any given combination of range and measurement speed.

Section 4
Maintenance

WARNING

THESE SERVICING INSTRUCITONS ARE FOR USE BY QUALIFIED PERSONNEL ONLY. TO AVOID ELECTRIC SHOCK, DO NOT PERFORM ANY SERVICING OTHER THAN THAT CONTAINED IN THE OPERATING INSTRUCTIONS UNLESS YOU ARE QUALIFIED TO DO SO.

4-1. INTRODUCTION

4-2. This section of the manual contains maintenance information for the Model 2240C Data Logger. This includes service information, general maintenance, and a performance test. The performance test is recommended as an acceptance test when the instrument is first received, and later as a calibration procedure to verify instrument specifications. A calibration cycle of 1 year is recommended to maintain the 2240C within the 1-year specifications. If the 90-day specifications are to be maintained, a 90-day calibration cycle is recommended. Table 4-1 lists the recommended test equipment necessary to execute the performance test and calibration adjustments. If the specified equipment is not available, alternate equipment having equivalent specifications may be substituted.

4-3. SERVICE INFORMATION

4-4. The 2240C is warranted for a period of 1-year upon delivery to the original purchase. The WARRANTY is given on the back of the title page located in the front of the manual.

4-5. Factory authorized calibration and service for each Fluke product is available at various worldwide locations. A complete list of these service centers is included with the WARRANTY. Shipping information is given in Section 2 of this manual. If requested, an estimate will be provided to the customer before any repair work is begun on instruments that are beyond the warranty period.

4-6. GENERAL MAINTENANCE

4-7. Access Information

WARNING

LETHAL VOLTAGES MAY BE PRESENT AT THE LINE POWER INPUT CONNECTOR AND THE POWER SUPPLY PCB ASSEMBLY WHEN THE 2240C IS

Table 4-1. Recommended Test Equipment

INSTRUMENT	RECOMMENDED MODEL
DC VOLTAGE CALIBRATOR	FLUKE 343A
DVM	FLUKE 8050A
LOW LEVEL SCANNER	FLUKE OPTION –06
INPUT CONNECTOR	FLUKE OPTION –07 OR –08

CONNECTED TO LINE POWER. LETHAL COMMON MODE VOLTAGES MAY ALSO BE PRESENT AT THE SCANNER INPUT CONNECTORS AND SCANNER PCB'S EVEN THOUGH THE LINE POWER CORD IS DISCONNECTED.

4-8. CALIBRATION ADJUSTMENTS

4-9. All calibration adjustments and all plug-in options within the data logger can be accessed for maintenance purposes by removing the top dust cover and the two inner covers located in the top rear of the instrument. Six phillips-head screws hold the top dust cover in place.

4-10. SEIKO MODEL 102 PRINTER HEAD

4-11. Use the following procedure to remove the printer head from the 2240C:

1. Remove the top dust cover from the 2240C

2. Locate the hinges for the printer's front panel assembly and, with the panel closed, apply pressure, using a thumb or finger, to the rear of one of the hinges. The hinge will snap apart.

3. Using a lateral motion, separate the other hinge and remove the printer's front panel.

4. Disconnect the printer's cable and connector assembly from the Printer Driver PCB. (The cable is located at the bottom of the printer bulkhead.)

5. Remove the four large mounting screws at the rear of the printer bulkhead. Support the printer with one hand while removing these screws. (The use of an offset Phillips-head screwdriver is suggested.)

6. Fully extend the paper drawer and work the top of the printer through the front panel opening. Tilt the printer forward and rest it on the paper drawer.

7. Push the cable through the bulkhead bushing and cable clamp to obtain about 4- to 5-inches of free cable at the printer.

8. Remove the printer's cable clamp and cable bushing from the printer bulkhead.

9. Remove the cable from the bushing slot and slide both the cable and connector past the extended printer drawer.

10. Logically reverse this procedure to install the printer head.

4-12. Cleaning

4-13. Clean the Model 2240C periodically to remove dust, grease, and other contamination. Separate procedures are given below for cleaning the Seiko Model 102 Printer Head, and the 2240C cables and pcbs.

4-14. SEIKO MODEL 102 PRINTER HEAD

4-15. The printer should be cleaned after using 10 packs of paper or every 90-days. Use the following procedure:

1. Remove the printer head from the chassis using the procedure given in previous paragraphs.

2. Use a brush or vacuum cleaner to remove dust and other clinging particles.

3. Clean the face of the print drum using a hard bristle brush.

4. Use alcohol or benzine to remove grease and grime from the printer.

CAUTION

The use of thinner, tri-chlorothelene, ketone, etc., may cause damage to plastic parts on the printer.

4-16. CABLE AND PCBS

4-17. Use the following procedure to clean the interface cables and pcbs used with the data logger.

1. Clean the cables with a soft cloth dampened with a mild solution of detergent and water.

2. Clean the surface of the pcbs using clean, dry air at low pressure ($\leq$20 psi). If grease is encountered, spray with Freon T.F. Degreaser and remove grime with clean, dry air at low pressure.

4-18. Lubrication

4-19. The Seiko Model 102 Printer should be lubricated every 6- months under normal use conditions and, if necessary, after cleaning. Refer to Figure 4-1 and apply the specified lubricant, 02 or G2, to the points indicated. Use a syringe for

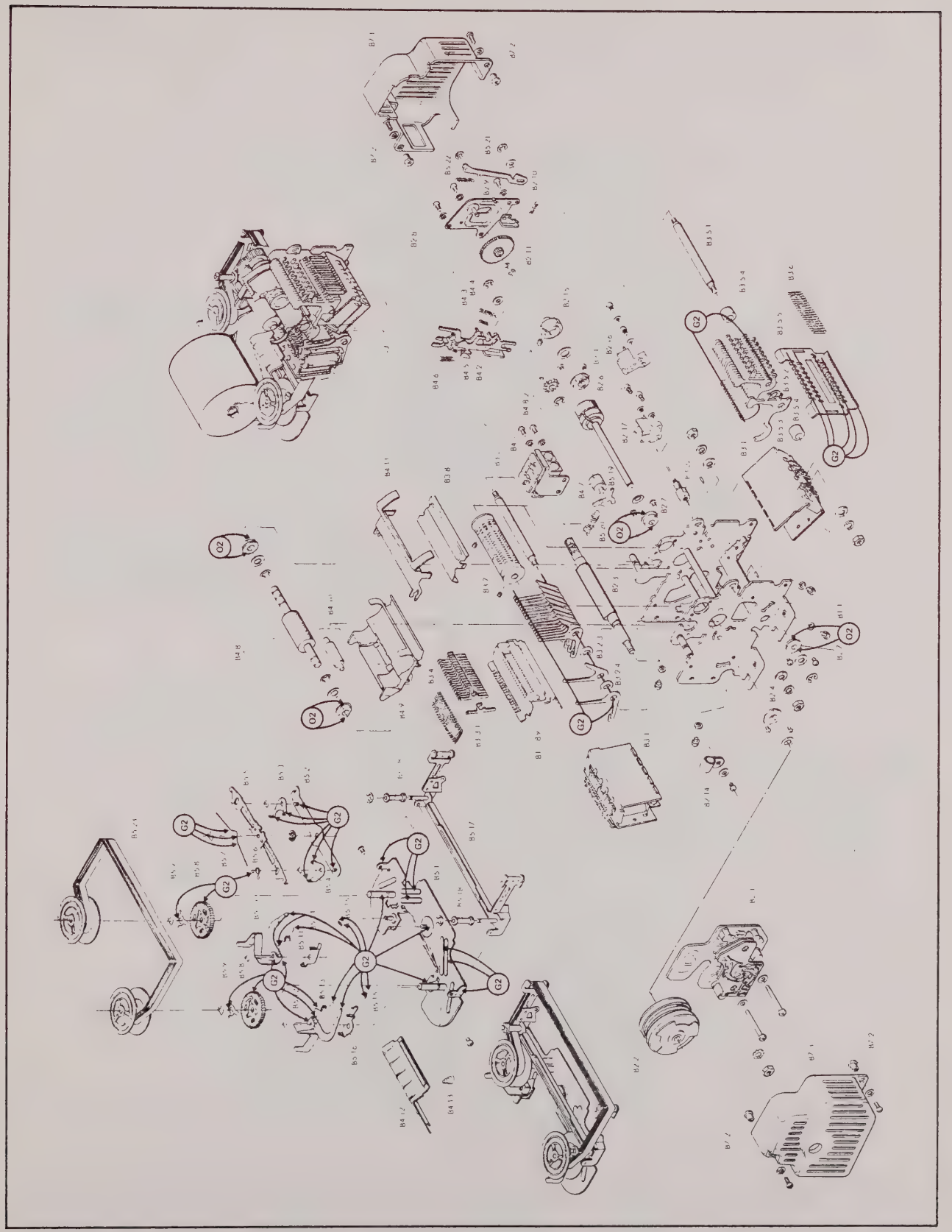


Figure 4-1. Lubrication Chart

hard-to-reach lubrication points.

NOTE

The required lubricants. O2 and G2, can be purchased from: C. Itoh and Co., telephone: (213) 390-7778.

4-20. Internal Switch Settings

4-21. A series of switches on the inside of the 2240C allows the user to select, and thereby, define certain 2240C operating characteristics. These include: Option -43 and -44 temperature scale (C/ F), programming mode (individual/block), format of printed and/or recorded data (alarm all/once), A/D converter measurement speed (fast/slow), line voltage, and frequency. Figure 4-2 identifies each of the switch locations. Procedures for setting the switches are given in the following paragraphs.

4-22. INDIVIDUAL/BLOCK PROGRAMMING

4-23. The individual or block programming mode, as described in Section 2 of this manual, can be selected by setting switch 4 on the Controller PCB Assembly; ON selects the individual mode, and OFF selects the block mode. See Figure 4-2.

4-24. PRINT/RECORD FORMAT

4-25. The data formats for recorded data, as described in Section 2 of this manual, can be selected by setting switches 1 and 2 on the Controller PCB Assembly. See Figure 4-1. To format externally recorded data, set switch 2 to ON for all data, or to OFF for alarm data. Printed data format is selected by setting switch 2 to ON for all alarms, or to OFF for alarm once.

4-26. INPUT POWER SELECTION

WARNING

LETHAL VOLTAGE MAY BE PRESENT AT THE LINE POWER INPUT CONNECTOR AND THE POWER SUPPLY PCB ASSEMBLY WHEN THE 2240C IS CONNECTED TO LINE POWER. LETHAL COMMON MODE VOLTAGES MAY ALSO BE PRESENT AT THE SCANNER INPUT CONNECTORS AND SCANNER PCB'S EVEN THOUGH THE LINE POWER CORD IS DISCONNECTED.

4-27. The 2240C can be operated from either 100, 115, 230V ac, 50 or 60 Hz line power depending upon the combination specified at the time of purchase. Before connecting the 2240C to line

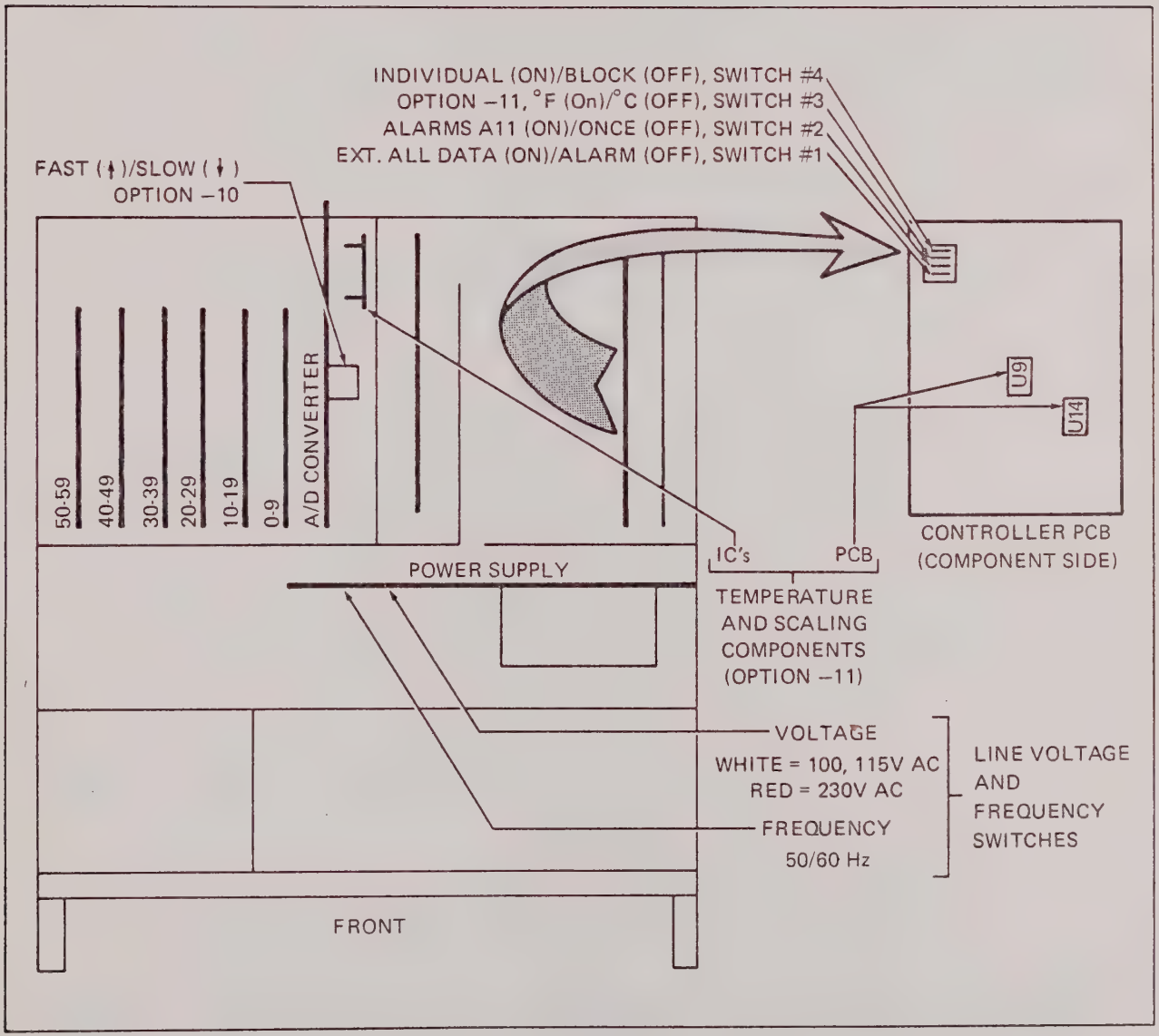


Figure 4-2. Internal Switch Locations

power, check and, if necessary, set the line voltage and the line frequency switches on the Power Supply PCB as follows:

1. Remove the top dust cover from the instrument.

2. Locate the line voltage switch shown in Figure 4-2.

3. Refer to the rear panel decal and use a screwdriver to set the slide switch so that the specified voltage (100/115 [white] or 230V ac [red]) appears in the slide aperature.

4. Locate the line frequency switch shown in Figure 4-2.

5. Set the switch to the line frequency (50 to 60 Hz) specified on the rear panel decal.

NOTE

If it becomes necessary to change the line frequency from that originally specified, a crystal on the guard crossing must be changed. Contact your nearest Fluke Representative or the John Fluke Mfg. Co., Inc.

6. Install the proper fuse is the rear panel fuse holder. See Fuse Replacement procedure in the following paragraph.

7. Install the top dust cover.

4-28. Fuse Replacement

WARNING

DISCONNECT THE UNIT FROM LINE POWER BEFORE ATTEMPTING FUSE REPLACMENT.

4-29. The power fuse is located on the rear panel of the data logger. If replacement is necessary, select the fuse rating according to the local line voltage as listed below:

1. 100v ac - 3/4A Slo-Blo

2. 115V ac - 3/4A Slo-Blo

3. 230V ac - 3/8A Slo-Blo

NOTE

The fuse holder cap can be replaced with a metric cap (John Fluke P/N 424440) which will accept 5 mm x 20 mm fuses.

4-30. Service Tools

4-31. A special interface cable is required to execute the Performance Test given later in this section. The cable is fabricated using either of the available input connectors, (Option -07 or -08) and a length of 20 gauge insulated wire. The instructions necessary to fabricate the cable are given in Figure 4-3.

4-32. A set of PCB Extender Cables is available for servicing the plug-in pcb's contained in the data logger. The Extender Cables are available as accessories and are described in Section 6, Option and Accessory Information.

4-33. PERFORMANCE TEST

4-34. The performance test is designed to verify the overall operation of the 2240C, and is intended for use as an acceptance test and/or periodic maintenance check. The equipment used in the test is specified in Table 4-1. The entire test should be executed in the sequence given. If the 2240C fails any part of the performance test, corrective action is indicated. Troubleshooting information is given at the end of the section.

4-35. Set-Up Procedure

4-36. Prior to executing the performance test complete the following set-up procedure:

1. Install a Low Level Scanner (Option -06) in slot 0 (Channel 0-9) of the 2240C. The dust cover and the left-rear inner guard should be removed of the duration of the performance test.

2. Set switch #2 on the A3 Controller PCB to OFF (Alarms Once).

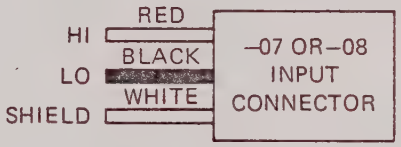
3. Attach the test cable described earlier under Service Tools to the scanner in slot 0.

4. Connect the free end of the test cable to the output of the DC Voltage Calibrator (red to +, black to -, and white to ground).

5. Set the DC Voltage Calibrator for a 0V dc output.

6. Energize the DC Voltage Calibrator.

7. Press the RESET switch in the 2240C's SCAN CONTROL



Use the following procedure to prepare the above test cable:

1. Cut a 24-inch length of each of the following wires. Use insulated, 20 guage, standard wire:
   a. RED
   b. BLACK
   c. WHITE

2. Refer to the connector decal for pin locations and connect the wires from step 1 to the following connector inputs:
   a. RED wire to HI-0, HI-4, and HI-5
   b. BLACK wire to LO-0, LO-4, and LO-5
   c. WHITE wire to SH-0, SH-4, and SH-5

3. Strip ½ inch of insulation from the free ends of the red, black and white wires, and tin the exposed wire.

4. Install the following jumpers on the input connector. Use bare copper hook-up wire:
   a. LO-1 to HI-1
   b. LO-2 to HI-2
   c. LO-3 to HI-3
   d. LO-6 to HI-6
   e. LO-7 to HI-7
   f. LO-8 to HI-8
   g. LO-9 to HI-9

Figure 4-3. 2240C Test Cable

group.

8. Press the ALL DATA switch in the PRINTER ENABLE group. Release all other switches in the OUTPUT CONTROL group.

9. Connect the 2240C to line power and set the Power switch to POWER ON. The DATA display should read 2240c 7 for = 3 seconds and then begin to read elapsed time. The POWER FAILURE RE-ENTER TIME lamp in the TIME ENTRY group should begin to flash.

NOTE

The initial display identifies the 2240C and the control firmware version installed in the instrument.

4-37. Display and Data Entry Test

4-38. Use the following procedure to check the operation of the 2240C display and data entry switches:

1. Complete the Set-Up procedure.

2. Press the FIXED DATA switch in the SCAN FORMAT group. All annuciators and the CHANNEL display should be out. the fixed data currently in memory should appear at the DATA display.

3. Using the DATA ENTRY keyboard, enter a series of six 1's. The DATA display should read 111111.

4. Press CLEAR ENTRY switch and enter six 2's on the keyboard. The DATA display should read 222222.

5. Press CLEAR ENTRY switch and repeat the previous step using a series of 3's, 4's, 5's, 6's, 7's, 8's, 9's, and 0's. The entered data should appear on the DATA display.

6. Press the MONITOR CHANNEL switch in the SCAN FORMAT group. The monitor channel currently in memory should appear at the CHANNEL display.

7. Using the DATA ENTRY keyboard enter a series of the three 1's. The CHANNEL display should read 111.

8. Press CLEAR ENTRY switch and enter three 2's on the keyboard. The CHANNEL display should read 222.

9. Press CLEAR ENTRY switch and repeat the previous step using a series of 3's, 4's, 5's, 6's, 7's,

8's, 9's, and 0's. The entered data should appear on the CHANNEL display.

4-39. Date and Time Test

4-40. Use the following procedure to check the operation of the time-of-year clock.

1. Press the DAYS switch in the TIME ENTRY group. All annunciators and the DATA display should be out. The day code currently in memory should appear on the DAY (CHANNEL) display (000 if day code has not been entered since power was turned on).

2. Using the DATA ENTRY keyboard, enter 222 and press the ENTER/STEP switch. The DAY display should read 222 along with hours, minutes, and seconds on the DATA display. The power failure LED should no longer flash.

3. Press the HR:MIN:SEC switch in the TIME ENTRY group. The DAY display should go out and the DATA display should read the time-of-day currently in memory.

4. Using the DATA ENTRY keyboard, enter 235950. The entered data should appear on the DATA display as 23 hours. 59 minutes and 50 seconds.

5. Press the ENTER/STEP switch and observe the display. The clock should start running the instant the ENTER/STEP switch is pressed. When the clock makes the transition from 23:59:59: to 00:00:00 ensure that the DAY display changes from 222 to 223.

6. Press HR:MIN:SEC in the TIME ENTRY group and enter 489999 on the DATA ENTRY keyboard.

7. Press the ENTER/STEP switch while observing the display. The reading should change to 225 01:40:40 and begin counting.

4-41. Scan Format Test

4-42. Use the following procedure to check the operation of the SCAN FORMAT switches and the associated memory.

1. Press the FIXED DATA switch in the SCAN FORMAT group.

2. Using the DATA ENTRY keyboard, enter 123456 and press the ENTER/STEP switch.

3. Press the FIRST CHANNEL switch in the SCAN FORMAT group. the first channel currently in memory will be displayed.

4. Enter 0 on the DATA ENTRY keyboard and press the ENTER/STEP switch. The CHANNEL DISPLAY should read 000.

5. Press the LAST CHANNEL switch in the SCAN FORMAT group. The last channel currently in memory will be displayed.

6. Enter 59 on the DATA ENTRY keyboard and press the ENTER/STEP switch. The CHANNEL DISPLAY should read 059.

7. Press the INTERVAL HR:MIN:SEC switch in the SCAN FORMAT group. The time interval currently in memory will be displayed in HR:MIN:SEC on the DATA display.

8. Enter 10 on the DATA ENTRY keyboard and press the ENTER/STEP switch. The DATA DISPLAY should read 00.00.10.

9. Press the SECOND FUNCTION switch, then press the SECOND INTERVAL switch, followed by the ENTER/STEP switch. The display will contain a string of t's, indicating the data logger is in the SECOND INTERVAL mode.

10. Press the SECOND FUNCTION switch, followed by the FIRST CHANNEL switch, press 5, then press the ENTER/STEP switch. The CHANNEL DISPLAY should read 005, the first channel to be scanned at the second interval.

11. Press the SECOND FUNCTION switch, then the LAST CHANNEL switch. Press 1, then press 0 twice, then press the ENTER/STEP switch. The channel display should read 100, the last channel to be scanned at the second interval.

12. Press the SECOND FUNCTION switch, then press the INTERVAL HR MIN SEC switch. Press 1, then press 0 four times to shift the 1 into the hours position. Press the ENTER/STEP switch to enter a second interval of 1 hour.

13. To check the TIME AVERAGE function, press the SECOND FUNCTION switch, then the TIME AVERAGE switch, followed by a 2 and a 0. This establishes the time average mode and set the number of scans at 20. A single t will appear in the display to

indicate the TIME AVERAGE mode.

14. Press the SECOND FUNCTION switch, then the FIRST CHANNEL switch, followed by a 9 and the ENTER/STEP switch t establish channel number 9 as the last channel to be average.

15. Press the SECOND FUNCTION switch, then the LAST CHANNEL switch, followed by a 9 and the ENTER/STEP switch to establish channel number 9 as the last channel to be averaged.

16. To establish a 30-second scan interval, press SECOND FUNCTION, then INTERVAL HR MIN SEC, then 3 and 0, followed by ENTER/STEP. Channels 3 through 9 will be scanned and averaged every 30 seconds.

17. To check the GROUP AVERAGE function, press the SECOND FUNCTION switch, then the GROUP AVERAGE switch, followed by 5 and ENTER/STEP. This establishes the group average mode and sets the group size to 5 channels. A single 6 in the display simulates a g for group average mode.

18. Press the SECOND FUNCTION switch, the FIRST CHANNEL switch, the 0, then the ENTER/STEP switch. Press the SECOND FUNCTION switch, the LAST CHANNEL switch, a 1 and a 9, then the ENTER/STEP switch. This sets the first channel (0) and the last channel (19) encompassed in group averaging.

19. Press the SECOND FUNCTION switch, then the INTERVAL HR MIN SEC switch, then 1, 0, 0, followed by the ENTER/STEP switch. This establishes a group average scan interval of one minute. Four groups, each consisting of five channels, will be scanned and averaged once each minute.

20. Press the MONITOR CHANNEL switch in the SCAN FORMAT group. The CHANNEL displays should read the monitor channel currently in memory.

21. Enter 5 on the DATA ENTRY keyboard and press the ENTER/STEP switch. The CHANNEL display should read 005.

22. Press the SINGLE CHANNEL switch in the DISPLAY CONTROL group. The single channel currently in memory will be displayed.

23. Enter 4 on the DATA ENTRY keyboard and then press the ENTER/STEP switch. The CHANNEL display should read 004.

24. Starting with FIXED DATA sequentially press each switch in the SCAN FORMAT group and ensure that the previously entered data is displayed.

25. Press the SINGLE CHANNEL switch in the DISPLAY CONTROL group and verify the presence of previously entered data.

26. Set the Power switch to POWER OFF for at least 1-minute and then set it to POWER ON. The POWER FAILURE RE-ENTER TIME lamp should begin to flash.

27. Repeat steps 13. and 14.

28. Reset the POWER FAILURE RE-ENTER TIME lamp by pressing the DAY or HR:MIN:SEC switch in the TIME ENTRY group and the ENTER/STEP switch on the DATA ENTRY keyboard.

4-43. Channel Programming Test

4-44. Use the following procedure to check the operation of the channel programming circuits:

1. Press RESET in the SCAN CONTROL group.

2. Press ALL DATA in PRINTER ENABLE group.

3. Press the PROGRAM LIST switch. The printer should print the date and time; interval in hours, minutes, and seconds; fixed data; the monitor channel; and all available limit addresses (60 maximum) and their assigned values. This data is then followed by a list of all channels within the limits defined by the scan format, primary channels first followed by secondary (time/group average, second interval) channels (if installed). The assigned measurement function and scale is printed on the channel line. If limits data has been assigned to the channel, the limit address, high (>) or low (<) sense, and the limit value is printed on the line following the channel data. If a channel is programmed to skip, function, scale, and limits data will not accompany the channel number.

4. Press the ENABLE switch in the CHANNEL PROGRAMMING group and enter the number of the first channel listed by the printer. Press the ENTER/STEP switch. The ENTER FUNCTION lamp should light.

5. Press the SKIP switch on the DATA ENTRY keyboard and then press the ENTER/STEP switch.

6. Identify the next channel printed on the program list and enter it on the DATA ENTRY keyboard.

NOTE

When practical, use the ADVANCE ADDRESS switch to call up the next applicable channel.

7. Press the REPEAT switch in the CHANNEL PROGRAMMING switch group.

8. Repeat step 6 and 7 of this procedure for all remianing channels listed by the printer.

9. Press the PROGRAM LIST switch. Heading data, limits data, and channel numbers will be printed. However, channel function data for primary channels will not be printed.

10. Press the ENABLE switch in the CHANNEL PROGRAMMING group and enter an address of 0.

11. Press the ENTER/STEP switch. The ENTER FUNCTION lamp should light.

12. Select the 4V function on the DATA ENTRY keyboard and press the ENTER/STEP switch.

13. If the scaling option (-40) is installed, press SKIP and ENTER/STEP switches.

14. If the Limit Option (-41) is installed, press the SKIP and ENTER/STEP switches for LIMIT A, LIMIT B, LIMIT C, and LIMIT D. The CHANNEL ENTER ADDRESS lamp should light.

15. Enter an address of 4 using the DATA ENTRY keyboard and press the ENTER/STEP switch.

16. Sequentially press the REPEAT, ADVANCE ADDRESS, and the REPEAT switches.

17. Call the following channel addresses using the DATA ENTRY and ENTER/STEP switches, and press the REPEAT switch after each is entered: 10, 15, 20, 25, 30, 35, 40, 45, 50, 55.

18. Press the PROGRAM LIST switch. The standard heading and each of the programmed channels and their function should be printed.

19. Set the Power switch to POWER OFF for 1 minute and then set it to POWER ON.

20. Repeat step 18. Program data should not change.

4-45. Scan Control Test

4-46. The following procedure checks the operation of the 2240C scan control logic and measurement circuitry:

NOTE

This procedure assumes that the data entered during the Scan Format and Channel Programming checks is still in memory.

1. Adjust the calibrator for an output of 1.0000V dc.

2. Press the SINGLE switch in the SCAN CONTROL group. The printer should record inputs of 1.0000V dc at channels 0, 4, and 5; and ØV dc at all channels that have not been skipped.

3. Press the STOP/RESET switch in the SCAN CONTROL group.

4. Press LAST CHANNEL in the SCAN FORMAT group, then press 9 and ENTER/STEP on the DATA ENTRY keyboard.

5. Set the DC Voltage Calibrator for an output of 2.0000V dc.

6. Press the INTERVAL switch in the SCAN CONTROL group. The printer should record a 2.0000V dc reading for channels 0, 4, and 5. The scan-cycle start should repeat itself at the programmed interval (10 sec).

7. Press the SECOND FUNCTION switch, then press the SECOND INTERVAL switch, followed by the ENTER/STEP switch. The display will contain a string of t's, indicating data logger is in the SECOND INTERVAL mode.

8. Press the SECOND FUNCTION switch, then the INTERVAL HR MIN SEC switch. Press 0 to set the second interval time to 0, then press ENTER STEP. A scan will not occur at the second interval.

9. Press the MONITOR switch in the SCAN CONTROL group. The display should indicate a 2.0000V dc input to channel 5.

10. Increase the calibrator output to 5.0V dc. The DATA display should read uuuuu to indicate the presence

of an overrange voltage.

11. Press the CONTINUOUS switch in the SCAN CONTROL group, and the ALL DATA switch in the PRINTER ENABLE group. The printer should print :,--:-V for channels 0, 4, and 5 to indicate the presence of an overrange voltage. The scan cycle should continue to repeat with a minimum time between the end of one cycle and the start of the next.

12. Decrease the calibrator output to 3.0V dc.

13. Press the SINGLE CHANNEL switch in the DISPLAY CONTROL group followed by ENTER/STEP. The display should indicate a 3.0000V dc input at channel 4.

14. Press the STOP/RESET switch in the SCAN CONTROL group.

4-47. Output Control Test

4-48. Use the following procedure to check the operation of the OUTPUT CONTROL logic:

NOTE

This procedure assumes that the Scan Control Test has been completed and that the conditions existing at the end of that check are still present.

1. Press the ALARM DATA switch in the PRINTER ENABLE group and release the ALL DATA switch. Set the calibrator output to 5.0V dc.

2. Press the INTERVAL switch in the SCAN CONTROL group. The display should indicate an overrange for channels 0, 4, and 5, but the printer should not record data.

3. Reduce the output of the voltage calibrator to 3.9000V dc. After 10 seconds, the display should indicate 3.9000 volts for channels 0, 4, and 5, and the printer should not record data for either channel.

4. Press the INTERVAL DATA switch in the PRINTER ENABLE section of the OUTPUT CONTROL group.. The printer should record the displayed data for channels 0, 4, and 5 each time a scan sequence occurs.

5. Press the CONTINUOUS switch in the SCAN CONTROL group. The scan sequence should be continuously repeated, and data should be printed on the initial scan and every 10 seconds thereafter.

6. Press the RESET switch in the SCAN CONTROL group.

4-49. Display Control Test

4-50. Use the following procedure to check the operation of the DISPLAY CONTROL group:

1. Release all switches in the PRINTER ENABLE section of the OUTPUT CONTROL group.

2. Press the CONTINUOUS switch in the SCAN CONTROL group. The data logger should alternately display channels 0, 4, and 5, and their associated voltage readings.

3. Press the DATE AND TIME switch in the DISPLAY CONTROL group. The display should read date and time. The clock should be running.

NOTE

This procedure assumes that the Output Control Test has been completed and that the conditions existing at the end of that test are still present.

4-51. Limits Test

4-52. If the LIMIT Option (-41) is installed, use the following procedure to perform a functional limits check:

NOTE

This procedure assumes that the Display Control Test has been completed and that the conditions existing at the end of that test are still present.

1. Set the calibrator output to 0V dc.

2. Program and recall each of the available limits (1-60 using the following sense and value combinations: HI-1111, HI-2222, LO-0444, and LO-0888.

3. Program channel 5 as follows:

a. Channel Address = 5

b. Function = 4V

c. mx + b scaling = SKIP (if installed) (option 40)

d. Limit Address A = 1

e. Limit Address B = 16

f. Limit Address C = SKIP

g. Limit Address D = SKIP

4. Program limit address 1 as follows:

a. Limit Address = 1

b. Enter Sense = HI

c. Enter Value = 1248

5. Program limit address 16 as follows:

a. Limit Address = 16

b. Enter Sense = LO

c. Enter Value = 1244

6. Set the calibrator output for +1.246V dc.

7. Press MONITOR in SCAN CONTROL group. The display should indicate a voltage of approximately +1.246V on channel 5.

8. Increase the calibrator output until the display reads 1.248 VOLTS. At that time the LIMIT EXCEEDED indicator should start blinking.

9. Reduce the calibrator output for a display of 1.246 VOLTS and press the limit RESET switch. The LIMIT EXCEEDED indicator should be off.

10. Reduce the calibrator output for a display of 1.244 VOLTS. At that time the LIMIT EXCEEDED indicator should start blinking.

11. Increase the calibrator ouptut for a display of 1.246 VOLTS and press the limit RESET switch. The LIMIT EXCEEDED indicator should be off.

12. Press the RESET switch in the SCAN CONTROL group.

4-53. mx + b Scaling Test

4-54. Use the following procedure to check the operation of the mx + b Scaling Option (Option -40).

NOTE

The values used in the following test are based on the programming example given in the mx + b Scaling Option (-40) part of Section 6. These values represent a pressure transducer input, through a Current Transmitter Connector (Option 29).

1. Adjust the calibrator output to 60 mV.

2. Press the SECOND FUNCTION button located in the DATA ENTRY section of the front panel, then press the ENTER ADDRESS button in the LIMITS/mx+b programming section.

3. Press one or two digits (1-30) in the DATA ENTRY front panel section to select a mx+b address, then press the ENTER/STEP button. Example: press 5, then ENTER/STEP to assign an address of 5 to the scaling functoin. After pressing ENTER/STEP, both the SENSE/mx + b light and the HI/m light will be on, indicating that the slope value (m) should be entered next.

4. To enter the slope value, press the appropriate digits in the DATA ENTRY group, then press the ENTER/STEP button. Example: press 0, 4, 1, 6, 7, then ENTER/STEP to enter a slope of 0.4167. After pressing ENTER/STEP, both the SENSE/mx+b light and the LO/b light will be on, indicating that an intercept value (b) should be entered next.

5. To enter an intercept value, press the appropriate digit switches in the front panel DATA ENTRY group, then press ENTER/STEP. Example: press 7, 5, 0, 0, and ENTER/STEP to enter an intercept value of 7500. After ENTER/STEP is pressed, the DECIMAL lights will be on, indicating a decimal point location may be entered next.

6. To enter a decimal point position, press the digit in the DATA ENTRY group that represents the number of digits to the right of the decimal point, then press ENTER/STEP. Example: press 2 then ENTER/STEP.

In this case, the DISPLAY would read 200.00 to indicate 200 psi. After ENTER/STEP is pressed, the UNITS lamp will be on, indicating that engineering units notation may be programmed next.

7. To program engineering units notation, enter the appropriate 2-digit code (refer to Table ?????) for the units desired, then press 1, 1, and ENTER/STEP. Engineering Units notation psi is programmed to appear on the printer.

8. Press the ENTER ADDRESS button in the CHANNEL programming group.

9. Press the appropriate digits in the DATA ENTRY front panel section to select the channel address. Example: Press 5 to select channel 5.

10. Press the ENTER/STEP button in the DATA ENTRY front panel section to enter the channel address. After the ENTER/STEP switch is pressed, the ENTER FUNCTION light in the CHANNEL section of the front panel will light.

11. Press the 400 mV button in the DATA ENTRY section of the front panel, then the ENTER/STEP switch, to enter a 400 mV A/D converter range. After the ENTER/STEP switch is pressed, the ENTER mx+b ADDRESS light in the CHANNEL section wll light.

12. Press the required digits in the DATA ENTRY front panel section necessary to enter the appropriate scaling function. Example: To enter scaling function address number 5, press 5, then ENTER/STEP.

13. Press the MONITOR button in the SCAN CONTROL front panel section. The DATA display should be: 200.00. The printer output should be: 200.00 psi.

14. Increase the calibrator output to 300 mV. The DATA display should be: 100.00. The printer output should be: 100.00 psi.

4-55. A/D Converter Accuracy Test

4-56. Use the following procedure to check the operation of the A/D Converter.

NOTE

This procedure assumes that the Limits Test, if applicable, has been completed and that the

conditions existing at the end of that test are still present.

1. Set the calibrator output to 0V dc.

2. Press the MONITOR switch in the SCAN CONTROL switch group.

3. Set the A/D Converter FAST/SLOW switch to SLOW.

4. Refer to Table 4-2 and sequentially enter each of the input voltage and data logger range combinations for channel 5 (monitor channel). As each entry is completed, check the data logger display against the indicated display readings.

5. Disconnect the calibrator, and remove the test cable and the scanner from the 2240C.

6. Install the inner guard cover and the top dust cover.

7. Set 2240B POWER switch to OFF and disconnect the line power.

4-57. Calibration

4-58. The 2240C should be calibrated once every year or 90-days (as required to maintainn desired accuracy) or whenever repairs have been made in the Power Supply or the A/D Converter. Calibration should be accomplished at an ambient room temperature of +22°C to +25 C and a relative humidity of less than 70%. Table 4-1 lists the required equipment.

4-59. Initial Procedure

1. Remove the top dust cover from the 2240C.

2. Press the RESET switch in the SCAN CONTROL group.

3. Connect the 2240C to line power and set the Power switch to ON.

4. Allow the 2240C to stabilize for a period of not less than 1-hour.

4-60. Power Supply

4-61. Use the following procedure to calilbrate the Power Supply PCB:

1. Connect the DVM to TP1 (common) and TP2 (-10.2V dc) on the Power Supply PCB. See Figure 4-3.

Table 4-2. A/D Converter Accuracy Test Specifications

INPUT VOLTAGE	RANGE (FUNCTION)	DISPLAY READING (90-DAY SPECIFICATION, 20°C - 30°C AMBIENT) LOW LEVEL SCANNER (SLOW SPEED)
0.0V	40 mV	–003 to 0.003
0.0V	400 mV	–0.02 to 0.02
0.0V	4V	–0.0002 to 0.0002
0.0V	40V	–0.002 to 0.002
39.9 mV	40 mV	39.893 to 39.907
399 mV	400 mV	398.94 to 399.06
3.99V	4V	3.9894 to 3.9906
39.9V	40V	39.984 to 39.906

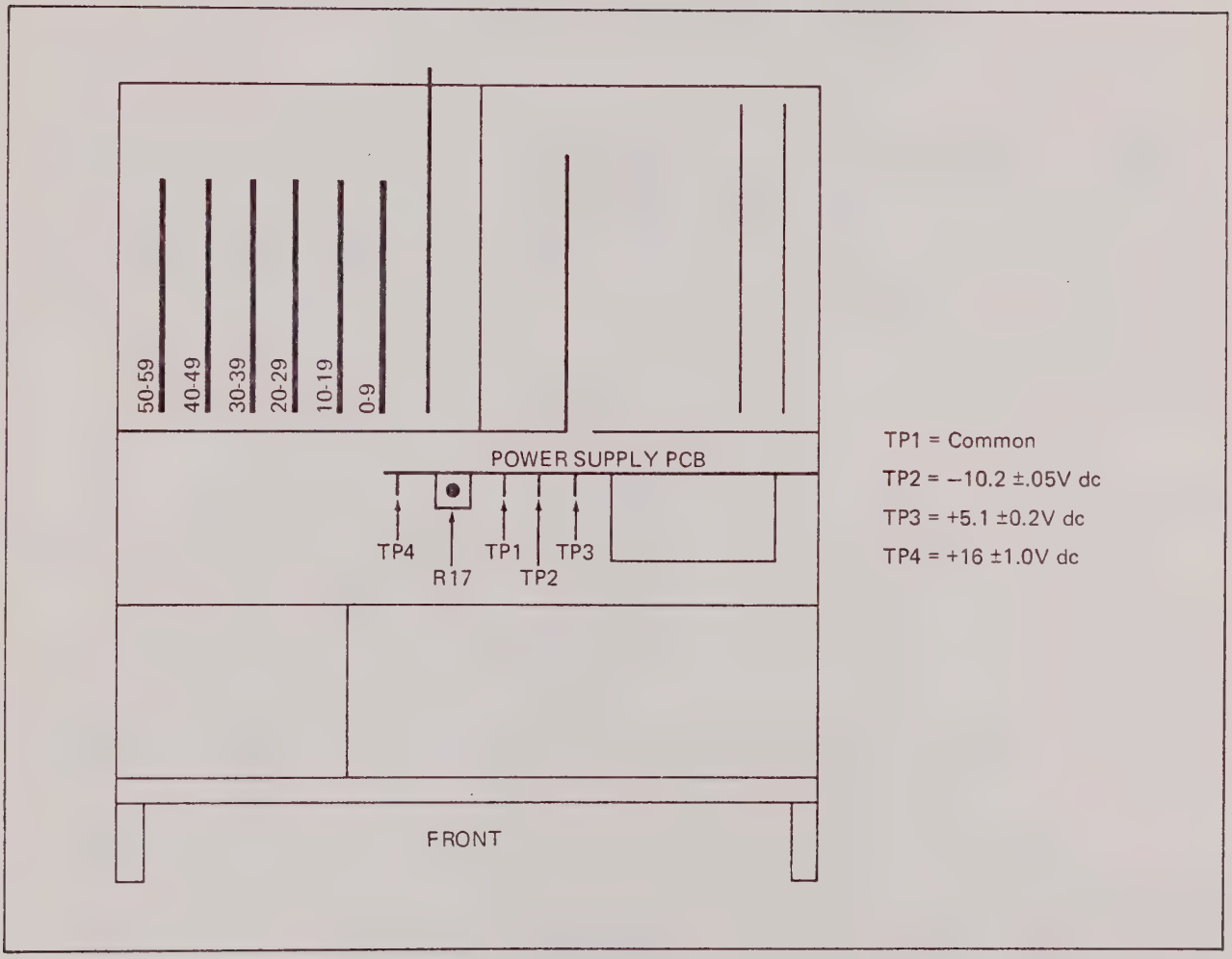


Figure 4-4. Power Supply Test Point and Adjustment Locations

2. Adjust pot R17 to obtain a reading of -10.20 ±0.05V dc.

3. Move the DVM input from TP2 to TP3. The DVM should read +5.1 ±0.2V dc.

4. Move the DVM input from TP3 to TP4. The DVM should read +16 ±1.0V dc.

4-62. A/D Converter

4-63. The High Performance A/D Converter should be calibrated when the data logger is calibrated or after major repairs have been made to the pcb. A dc calibrator and a DVM are required for calibration. The recommended instruments are listed in Table 4-1. The calibration adjustments are test points are all located on the A/D Converter PCB, and are shown in Figure 4-4. Use the following procedure to calibrate the High Performance A/D Converter:

CAUTION

Turn power off before removing or installing pcb's.

1. De-enerigize the data logger and press the STOP/RESET switch in the SCAN CONTROL group.

2. Install a Low Level Scanner (Option -06) in scanner slot 0 of the data logger.

3. Set the output of the dc calibrator to 0V, and, using a Solder Pin Connector (Option -07), connect the output of the dc calibrator to channel 0 of the scanner in slot 0.

4. Energize the data logger and program it to perform the following scan sequence:

   a. Monitor Channel 00.

   b. Function = 40 mV.

5. Set the Fast/Slow switch on the A/D Converter to Slow. See Figure 4-4.

6. Press the MONITOR switch and adjust the 40 mV ZERO pot (R7) for a zero indication i.e., the display alternates between a + and - polarity indication. Ignore the digital display.

NOTE

Under normal conditions steps 7

through 15 may be omitted from the calibration procedure. However, if the A/D Converter has been repaired prior to calibration, component parts have been replaced, or potentiometers, R46, R50, or R55, have been inadvertently adjusted, the steps must be executed.

7. Remove the inner guard cover.

8. Connect a DVM between TP4 (common) and TP8. Adjust R54 for a reading of 0 ±20 mV dc.

9. Program the data logger for the 4V function and set the dc calibrator for a +1 mV output.

10. Adjust R50 for the data logger display of 0.0010V.

11. Reverse the polarity of the dc calibrator output. The display of -0.0010V.

12. Set the Fast/Slow switch to Fast and adjust R46 for a display of -0.0010V.

13. Reverse the polarity of the dc calibrator output. The display should read 0.0010V.

14. Set the Fast/Slow switch to Slow.

15. Set the output of the dc calibrator to 0V.

16. Connect the DVM between TP4 and TP9.

17. Adjust R72 for a DVM reading of 0 +5 mV dc.

18. Install the inner guard cover. Allow the A/D Converter 30-minutes to stablize its temperature before proceeding.

19. Set the output of the dc calibrator to -3.0000 volts and adjust R12 for a display of 3.000V.

20. Reverse the polarity of the dc calibrator output. The reading should be -3.0000 ±0.0002V.

21. Set the dc calibrator output to +300 mV.

22. Program the data logger function to 400 mV and adjust R29 for a display of 300.00 mV.

23. Set the dc calibrator output to +60 mV.

24. Program the data logger function to 80 mV and adjust R36 for a display of 30000.

NOTE

The 80 mV function is programmed using the HI LIMIT switch on the 2240C.

25. Set the dc calibrator output to +30 mV.

26. Program the data logger function to 40 mV and adjust R32 for a reading of +30.000 mV.

27. Program the data logger to the 40V function and set the dc calibrator output to 0 volts. The display should read 0.000V.

28. Set the dc calibrator output to +30V and adjust R4 for a display of 30.000V.

29. Connect the DVM between TP1 (common) and TP3 on the A/D Converter PCB> Adjust R21 for a DVM display of +2.0000V dc.

30. Connect a DVM between TP1 and TP2. Adjust R44 for a DVM display of +20.000 mV.

31. Set the dc calibrator to 0 volts and program the data logger function to 40 mV. The data logger display should read 0.000V.

32. Set the Fast/Slow switch to speed at which the A/D Converter is to operate and adjust R7 for a data logger display of 0.000V.

4-64. Temperature and Scaling Option (Option -43 or -44)

4-65. The Temperature option does not require calibration. However, its accuracy is dependent upon the calibration of the A/D Converter and the Isothermal Block Connectors.

4-66. Isothermal Block Connectors (Option -08)

4-67. The basic 2240C is capable of housing up to six Isothermal Block Connectors (Option -08) for use in conjunction with the Temperature Option (Option -43 or -44). Each Isothermal Block Connector has periodic calibration. However, if a connector has been repaired or if the seal on the factory adjustment has been broken, calibration is required. Refer to subsection -08 in Section 6, Option and Accessory Information, for the calibration procedure.

4-68. TROUBLESHOOTING

CAUTION

Static discharge can damage MOS components contained in the 2240C. To prevent this possibility use the following precautions when troubleshooting and/or repairing the unit.

1. Never remove, install or otherwise connect or disconnect pcb's and/or components without first turning the 2240C Power switch to OFF.

2. Perform all repairs at a static-free work station.

3. Do not handle IC's or pcb's by their connectors.

4. Use static ground straps to discharge repair personnel.

5. Use conductive foam to store replacement or removed IC's.

6. Remove all plastic, vinyl, and Styrofoam products from the work area.

7. Use a grounded soldering iron.

4-69. A troubleshooting guide for the 2240C is given in Table 4-3. The guide is in the form of a tabular flow chart and is recommended for use in isolating a 2240C mainframe malfunction to the pcb (board) level. Details necessary to troubleshoot faulty pcb's to the component level can be derived from the schematic diagrams given in Section 8 and the theory of operation in Section 3.

4-70. When troubleshootng the 2240C in accordance with Table 4-3 the following notes apply.

1. Do not start in the middle of the procedure. Any given step assumes that the previous steps have been completed.

2. All measurements using external test equipment are referenced to logic common (TP1 on Power Supply PCB) unless otherwise specified.

3. All connectors referenced for measurement are accessible from the bottom of the 2240C when the bottom dust cover is removed. See Figure 4-5 for connector and pin identification.

Table 4-3. Troubleshooting

STEP NO.	INSTRUCTION	YES	NO	GO TO
1	Turn 2240C Power switch to OFF and disconnect power cord at rear panel.			2
2	Remove the top and bottom dust covers, and the two inner guard covers from the 2240C.			3
3	Remove all scanner pcb's and input connectors from the scanner section.			4
4	Remove all option pcb's that may be installed in the digital I/O section.			5
5	Remove the A/D Converter PCB and the Guard Crossing PCB.			6
6	Disconnect the printer cable at the Printer Driver PCB.			7
7	Connect the 2240C to line power and set the Power switch to POWER ON.			8
8	Refer to Power Supply Calibration procedure and verify the presence and accuracy of all power supply voltages. If necessary: a. Isolate and relieve any shorted output conditions. b. Repair and/or calibrate the power supply.			9
9	INITIAL TURN-ON			
9	Set the 2240C Power switch to POWER OFF, wait 10-seconds, and then to POWER ON. Observe the front panel display. Does it read 2240C 7?	10	19	
10	Does the display change to (000 000003) in approximately 3-seconds and begin to count-up?	11	14	
11	Is the POWER FAILURE LED on or blinking?	12	15	
12	Check the operation of the front panel keyboard. Do all keys appear to be operational?	13	18	
13	Initial turn-on appears normal.			40
14	If display continues to read 2240C 7 check for continuously low outputs on the following lines: Control Bus A – P32-7 (CA2) TIM – P32-31 (1Hz pulse train)			9
15	Is the IMPROPER ENTRY LED blinking?	16	17	
16	Check Control Bus B at P32-12 (CB3) for a continuously low condition.			9
17	Check for presence of In strobe at P32-15.			9
18	Check Control Bus B at P32-9 (CB0) and P32-10 for a continuously low condition.			9
19	Does the display read a series of 1111's (may go blank after initial turn-on)?	20	27	
20	Is the IMPROPER ENTRY LED blinking or on?	21	26	
21	Is the POWER FAILURE LED blinking?	22	25	
22	Does front panel keyboard appear to be operational?	23	24	
23	If all PROGRAMMING LIMITS LED's are lit, check P32-16 for the presence of the Out strobe. Also check for continuously low A0 through A7 outputs of J9 (pins 1 through 4 and 11 through 14).			9
24	Check Mode Switch PCB (U11 and U12).			9
25	If limit program prompting LED's are on, 2ϕ clock on controller is defective.			9
26	Check Control Bus A for continuously low outputs. P32-5, -6, -7, -8 (CA0, CA1, CA2, and CA3, respectively).			9
27	Is the display blank upon turn-on and remain blank?	28	30	

Table 4-3. Troubleshooting (cont)

STEP NO.	INSTRUCTION	YES	NO	GO TO
28	Does the POWER FAILURE LED blink and is the IMPROPER ENTRY LED off?	29	30	
29	Check U19-3 (BI) on the Mode Switch PCB. If continuously high, check the operation of U4 and U1 and the associated circuitry on the Mode Switch PCB.			9
30	Is the IMPROPER ENTRY LED blinking and the POWER FAIL LED off?	31	32	
31	If the PROGRAMMING LIMITS prompting LED's are lit the Power-On-Reset (POR) signal for the Power Supply PCB (J32-18) is continuously low. If all annunciator LED's (mV, V, Temperature, Date and Time) are lit, check for a continuously low condition at J42-13 (A) on the Mode Switch Assembly.			9
32	Check for the presence of a continuously low Sync pulse at J32-17.			9
33	Does a series of three like-characters appear in the CHANNEL display prior to the 3-second time out?	34	37	
34	Does data display read 888880?	35	36	
35	U9 on the Mode Switch Assembly and/or its associated circuitry is not operating.			9
36	Check the Data Bus at P32-1, -2, -3, and -4 (DB0, DB1, DB2, and DB3, respectively) for the presence of a continuously low output.			9
37	Does a series of three like-characters other than 000 appear in the CHANNEL display after the 3-second time out?	38	39	
38	Check the operation of U5 of the Mode switch.			9
39	If only one or two of the six display digits are lit, check for a continuously low condition at J42-10, -11, and -12 (D, C, B) on the Mode Switch PCB Assembly.			9
	DISPLAY AND DATA ENTRY			
40	Refer to Performance Test and complete the Display and Data Entry Test.			41
41	Does the display and keyboard respond properly?	61	42	
42	Does the keyboard appear to respond?	43	48	
43	Are all digits in a series of entered numbers displayed the same, e.g., 111111, 222222, etc.?	44	46	
44	Are digits displayed as entered on both DATA and CHANNEL displays?	45	47	
45	Defective Mode Switch Assembly, repair as required.			40
46	Some digits are blank or some character segments are not lit. Defective Display Assembly. Check U3 and U6 outputs. Check transistor drivers Q1 through Q11. Check LED elements by interchanging decades.			40
47	Channel Display PCB is defective. Check U1 and U4. Repair as required.			40
48	Make sure Power switch is set to POWER ON. Use scope to check for the presence of a 3 kHz clock at J45-4. Is clock present?	50	49	
49	Keyboard Logic PCB is defective. Check for presence of +5V dc and the operation of oscillator formed by U11. Repair as required.			40
50	Use scope to check for the presence of 1-2-4-8 outputs from binary counter. J45-10, -1, -8, -7 (1-2-4-8, respectively). Are counter outputs correct?	52	51	
51	Defective Keyboard Logic PCB. Check U12 and U16. Repair as required.			40
52	Use scope to monitor 3 kHz clock at P45-4 and individually press all front panel momentary type switches (not PAPER ADVANCE). The clock should stop when any one of the switches is depressed. Ignore order in which switches are pressed.			53

Table 4-3. Troubleshooting (cont)

STEP NO.	INSTRUCTION	YES	NO	GO TO
53	Does clock stop for each switch that is pressed?	54	58	
54	Keyboard Switch Assembly is functional.			55
55	Was a tone generated with any of the switch depressions?	57	56	
56	Check for presence of In and Out strobe pulses at J35-3 and J35-2, respectively. If not present, controller is defective. If present. Control Bus B decoder on Keyboard Logic PCB Assembly is defective. Also check tone generator circuit on Keyboard Logic PCB. Repair as required.			40
57	Check multiplexer operation of U6 and U7 on Keyboard Logic PCB Assembly. If okay, controller is defective. Repair as required.			40
58	Does clock stop for all switch depression except one of two?	59	60	
59	Switch is defective on Keyboard Switch PCB Assembly.			40
60	If clock does not stop for any switch depression, U1 on Keyboard Switch Assembly is defective. Repair as required.			52
	SCAN FORMAT			
61	Enter the following scan format data and observe the display as the ENTER/STEP switch is pressed for each entry: FIXED DATA – 123456 INTERVAL – 10-seconds FIRST CHANNEL – 0 MONITOR CHANNEL – 5 LAST CHANNEL – 10			62
62	Does display data change or shift when the ENTER/STEP switch is pressed? (The addition of leading zeros is not considered a change in data.)	63	64	
63	Check the following IC's on the Keyboard Memory PCB and repair as required: U1 – First, Last, and Monitor Channels U2 – Fixed and Interval Data			61
64	Set Power switch to POWER OFF, wait 1-minute, then return switch to POWER ON. Recall scan format data.			65
65	Is recalled data the same as previously entered?	67	66	
66	If recalled data comprises a series of 69's, the battery on the front-left chassis side is defective.			61
67	Program channels 0 through 10 with the following function and limit address data. Function – 4V **mx + b SCALING ADDRESS – Skip *LIMIT ADDRESS A – Skip *LIMIT ADDRESS B – Skip *LIMIT ADDRESS C – Skip *LIMIT ADDRESS D – Skip *Applicable only if the 2240C is equipped with limit option (–41). **Applicable only if the 2240C is equipped with mx + b scaling option (–40)			68
68	Did program prompting LED's react normally?	70	69	
69	Defective Keyboard Switch and/or Logic PCB.			67
70	Recall and verify the program data for channels 0 through 10.			71
71	Is recalled data correct?	73	72	

Table 4-3. Troubleshooting (cont)

STEP NO.	INSTRUCTION	YES	NO	GO TO
72	Memory IC's on Range and Function Memory PCB are defective. Try interchanging IC's and reprogramming to verify defect. Function IC U19 Limit A Address IC U20 Limit B Address IC U21 Limit C Address IC U22 Limit D Address IC U23			67
73	Sequentially press each of the SCAN CONTROL switches and observe the CHANNEL display to verify proper scanning operation in each mode. Ignore the DATA display characters. However, check the annunciator LED's to ensure that VOLTS is lit during the actual scan sequence (TEMPERATURE and MILLIVOLTS should blink). SINGLE – Single scan should occur. Channel data will stop and remain at 10. INTERVAL – Repeated scan sequences with a 10-second time interval between the start of each scan. Display will read the date and time between scans. MONITOR – Continuously displays channel 5. CONTINUOUS – Continuously scans channel 0-10 with a minimum delay (<1 second) between the end of one scan sequence and the start of the next. REMOTE – Displays date and time, no scan sequence.			74
74	Do all scan sequences react normally?	76	75	
75	Check the operation of each Mode switch and its associated driver on the Mode Switch PCB Assembly.			73
76	Press the CONTINUOUS scan mode switch.			77
77	Momentarily press the PAPER ADVANCE switch in the OUTPUT CONTROL switch group.			78
78	Does the scan sequence stop and remain at channel 10?	80	79	
79	Defective Printer Drive PCB or Mode Switch PCB. Repair is required.			80
80	Turn Power switch to POWER OFF then to POWER ON. Scan sequence will resume.			81
81	Turn Power switch to POWER OFF.			82
82	Connect Printer cable to Printer Drive PCB and set Power switch to ON.			83
83	Does printer sound like it's running?	85	84	
84	Check ±16V dc on Power Supply PCB. If voltage is okay, printer head is defective. Repair as required.			81
85	Press PAPER ADVANCE switch.			86
86	Does printer advance paper?	88	87	
87	If scan sequence stops, printer head is defective. Interrupting power will resume scan sequence. Repair or replace printer head.			81
88	Sequentially press the following switches: RESET (SCAN CONTROL) ALL DATA (PRINTER ENABLE) SINGLE (SCAN CONTROL) The printer should print: 			89

Table 4-3. Troubleshooting (cont)

STEP NO.	INSTRUCTION	YES	NO	GO TO
89	Release the ALL DATA switch and press ALARM DATA (PRINTER ENABLE).			90
90	Does the printer print?	91	92	
91	Note channels printed and verify that Limit addresses for those channels are skipped.			67
92	Release the ALARM DATA switch, press INTERVAL DATA and then press CONTINUOUS (SCAN CONTROL). The printer should print data for channels 0 through 10 once during each interval period. In this case, 10-seconds. The scan continues normally between intervals.			93
93	Release the INTERVAL DATA switch. The scanning sequence should continue, but data will not be printed.			94
94	Does the printer respond normally to the PRINTER ENABLE switch settings?	96	95	
95	Defective Mode Switch, Printer Drive PCB, or printer head. Repair as required.			88
	DISPLAY CONTROL TEST			
96	Press FIRST CHANNEL in the SCAN FORMAT group, and then CHANNEL ENABLE in the PROGRAMMING group. The display should read: 000 4.000 volts			97
97	Press ALL CHANNELS in the DISPLAY CONTROL group. The continuous scan of channels (0 through 10) should be displayed.			98
98	Press SINGLE CHANNEL in the DISPLAY CONTROL group. The CHANNEL display read 004.			100
99	Press DATE AND TIME in the DISPLAY CONTROL group. The time-of-day and date code should be displayed.			
100	Does the display respond normally to the DISPLAY CONTROL settings?	102	101	
101	Defective Keyboard Switch PCB or Keyboard Memory PCB. Repair as required.			96
	PROGRAM LIST			
102	Press RESET in the SCAN CONTROL group and ALL DATA in the PRINTER ENABLE group.			103
103	Press PROGRAM LIST. The printer should record:			104
104	Date and time, interval time, monitor channel, all available limits by address and their assigned values (may read any value at this point), all programmed channels (0-10) by address and their assigned function data, including second interval channels. All channels should show the 4V function (4.0000V).			
105	Missing column data indicates defective printer head. If no list is printed PROGRAM LIST switch or Printer Drive PCB may be defective. Missing digits in LIMIT data only indicates that the limits need programming or the Keyboard Memory PCB is defective. If this is the case, go to the next step. If printed data does not agree with displayed data, check the Printer Drive PCB.			102
	PROGRAMMING LIMITS			
106	If the limits option (−41) is installed, program each available limit (as indicated on the previously printed Program List) to <00000. Observe the display as each limit value is entered with the ENTER/STEP switch.			107

Table 4-3. Troubleshooting (cont)

STEP NO.	INSTRUCTION	YES	NO	GO TO
107	Does entered data for one or more limits addresses change when the ENTER/STEP switch is pressed?	108	109	
108	U18 on the Range and Function Memory PCB is defective. Repair is required.			106
109	Program channels 0 through 10 with the following function data, and review after entry.			

PROGRAM DATA			REVIEW DATA	
CHANNEL	FUNCTION		CHANNEL DISPLAY	DATA DISPLAY
0	T1	Enter skip if	000	1
1	T2	temperature	001	2
2	T3	option is not	002	3
3	T4	installed.	003	4
				or s s s
4		40 mV	004	40.000 Millivolts
5		400 mV	005	400.00 Millivolts
6		HI LIMIT	006	40000
7		4V	007	4.0000 Volts
8		40V	008	40.000 Volts
9		SKIP	009	s s s
10		SKIP	010	s s s

	Program data correctly entered and verified?			
	Defective range and function memory. Repair as required.			
	Turn Power switch to POWER OFF, install the Guard Crossing PCB and set the Power switch to POWER ON. Review channel data entered earlier in this procedure. The following results should be obtained for the units that display 2240 3 (4, 5, or 6) on initial turn-on.			

PROGRAM CHANNEL	CHANNEL DISPLAY	DATA DISPLAY
0	000	1
1	001	2 or s s s
2	002	3
3	003	4
4	*004	40.000 Millivolts (flashing)
5	005	400.00 Millivolts
6	*006	40000 (flashing)
7	007	4.0000 Volts
8	*008	40.000V (flashing)
9	009	s s s
10	010	s s s

110				110
111				109
112	Turn Power switch to POWER OFF, install Guard Crossing PCB and set the Power switch to POWER ON. Review channel data entered earlier in this procedure. The following results should be obtained for the units that display 2240C 7 on initial turn on.	112	111	
113.	Is reviewed channel data correct?	115	114	
114.	Guard crossing defective. Repair as required.			109
115	2240C Mainframe is operational.			

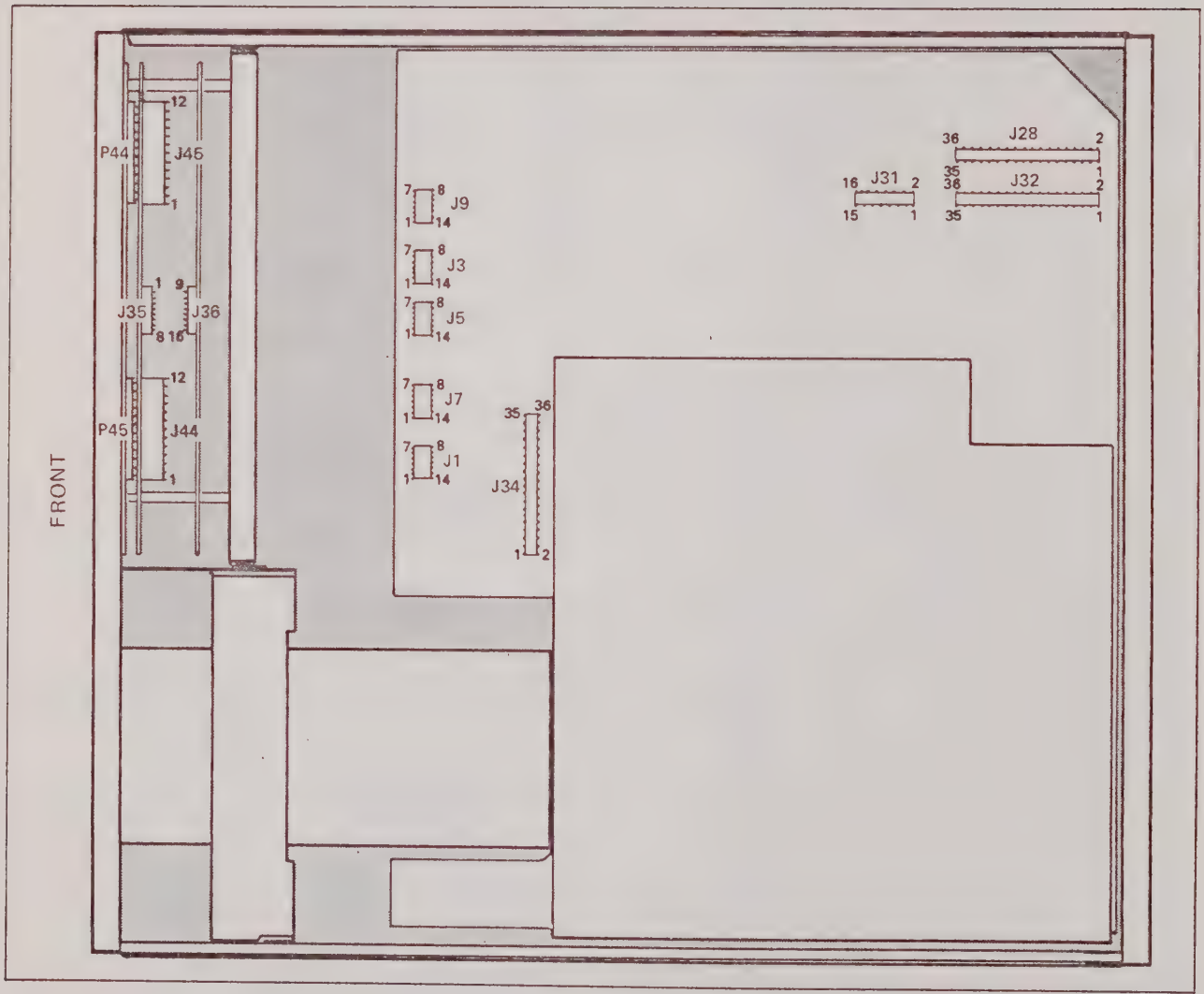


Figure 4-5. Measurement Point Locations for Troubleshooting (Bottom View)

Section 6
Table of Contents
Accessories

OPTION/ MODEL NO.	DESCRIPTION	PAGE NO.
M07-205-600	Rack Mounting Kit	600-1
M00-280-610	Rack Slide Kit	600-1
2200A-7005	Service Extender Cable Set	600-1
2200A-7006	General Purpose Interface Cable (6-ft)	600-1
2200A-7007	Interface Connector, Blank (50-pin)	600-2
2201A	Scanner Chassis	With 2201A
2202A	Remote Scanner Chassis	With 2202A
2203A	RTD Scanner Chassis	With 2203A
	Options	
-03	RTD Connector	603-1
-04	RTD Scanner	With 2203A
-05	General Purpose Scanner	605-1
-06	Low Level Scanner	606-1
-07	Solder Pin Connector	607-1
-08	Isothermal Block Connector	608-1
-12 Series	TTY/RS-232C Interface	612-1
-13 Series	Paper Tape Punch Interface	613-1
-14 Series	Magnetic Tape Interface	614-1
-15	IEEE Interface	615-1
-16	Digital Input Interface	616-1
-17	Remote Programming Interface	617-1
-18	Non-Standard Output Format (for -17)	617-1
-23	Alarm Set Point Option	623-1
-28	Current Transmitter, 1-5 mA	628-1
-29	Current Transmitter, 0-20 mA	629-1
-30	Current Transmitter, 10-50 mA	630-1
-32	Dual Interval	632-1
-33	Eight Channel RTD Scanner	633-1
-40	mx + b Scaling Option	640-1
-41	Alarm Setpoint Option	641-1
-42	Data Averaging Option	642-1
-43	Temperature Option	643-1
-44	Temperature Option	643-1

Section 6
Option and Accessories

6-1. INTRODUCTION

6-2. This section of the manual contains information concerning the options and accessories available for use with the Model 2240C. It consists of an introductory section, an accessories subsection and a series of option subsections. All options and accessories are listed by model or option number in the Table of Contents. Corresponding subsection page numbers and other documentation location information are also listed.

6-3. ACCESSORIES

6-4. Hardware type accessories, i.e., rack mounting kits and cables, are documented in the accessories subsection. However, the more complex accessories, (scanner chassis) are documented in stand-alone manuals which are provided with the purchased instrument.

6-5. OPTIONS

6-6. All currently available options are documented herein as individual subsections. Each subsection contains all of the information necessary to install, operate, and maintain the option. This includes a list of replaceable parts and a schematic.

6-7. The location of a particular subsection is facilitated by the use of unique page and paragraph numbering which corresponds to the option or accessory in question. For example, a 600-X series identifies the general accessories subsection and a 605-X series identifies the subsection for the -05 Option (where X is the sequential page or paragraph number).

Accessories

600-1. RACK MOUNTING KIT (M07-205-600)

600-2. The data logger can be rack-mounted in a standard 19-inch equipment rack using Rack Mounting Kit M07-205-600. Use the following procedure to install the kit:

1. Peel off the name plate decals from the front side-corners of the data logger.

2. Remove the front corner screws which match the hole pattern in the rack-mounting ears (see Figure 600-1).

3. Attach the rack-mounting ears to the front corners of the unit using the screws supplied in the rack-mounting kit.

600-3. RACK SLIDE KIT (M00-280-610)

600-4. The data logger can be rack-mounted in a 24-inch deep equipment rack using the Rack Slide Kit M00-280-610. Use the following procedure to install the kit:

1. Remove the horizontal side trim decal from both sides of the data logger.

2. Refer to Figure 600-2, and, using the screws supplied with the kit, attach the Chassis Section (B) of the slide kit to each side of the unit. Use the center row of mounting holes.

3. Install the cabinet Section (D) and the Center Section (C) in the equipment rack.

4. Pull the center section of the slide out through the front of the equipment rack until it locks in the extended position.

5. Depress the spring locks on the Chassis Section (B) and join Section B and C.

6. Push the instrument into the equipment rack and then pull it out to the extended position. The spring locks should limit the rack slide travel.

600-5. SERVICE EXTENDER CABLE SET (2200A-7005)

600-6. A set of three service extender cables is available for use in servicing any one of the data logger's vertical plug-in pcb's. The majority of the pcb's require the use of only one extender. However, some of the pcb's, such as the A/D Converter, require the use of the two cables. The third cable is used to

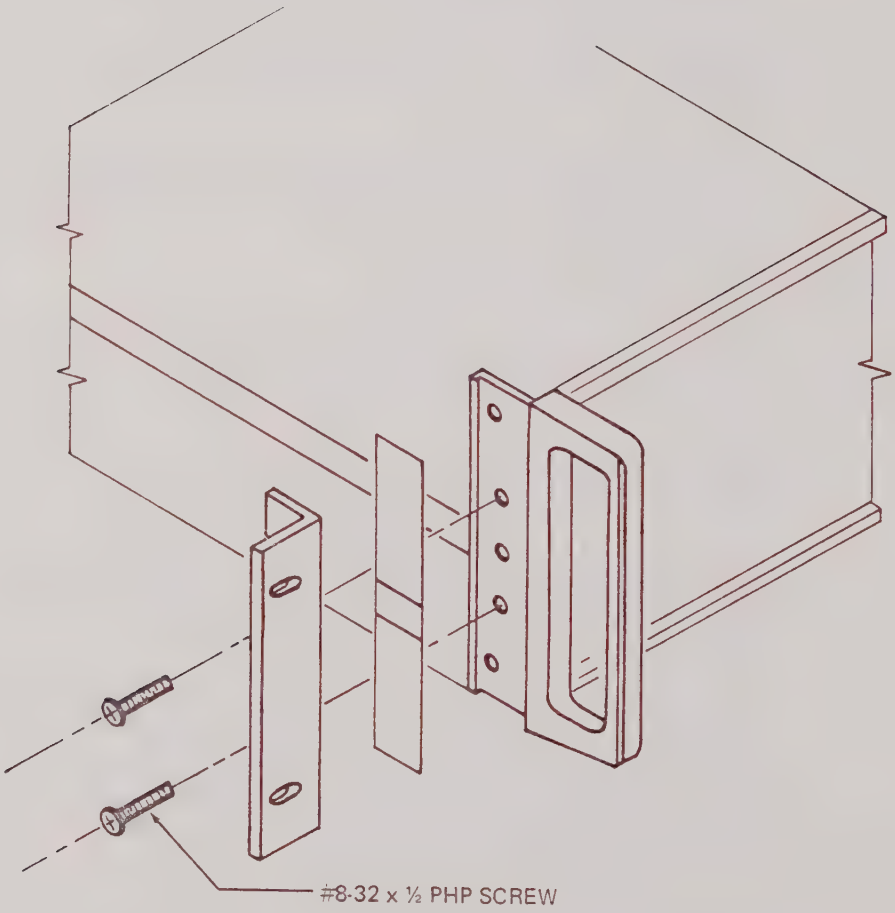


Figure 600-1. Rack Mounting Kit

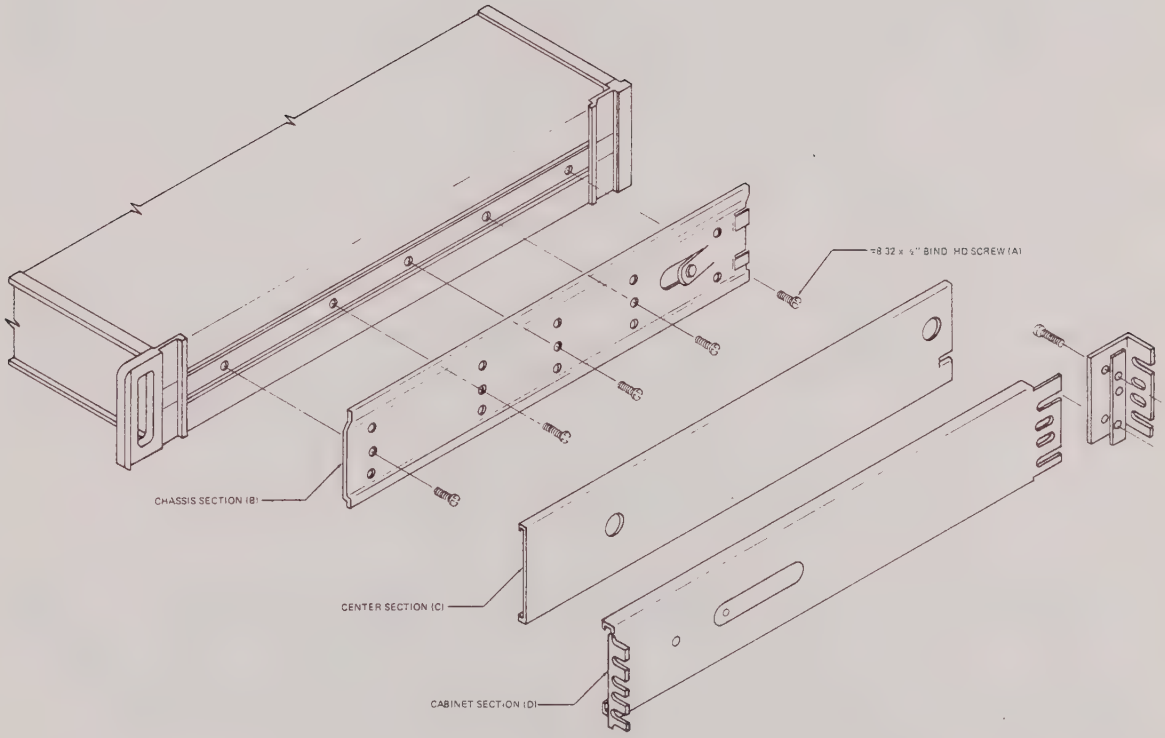


Figure 600-2. Rack Slide Kit

extend the Controller PCB. In addition, a set of six maintenance extender cables (Model A22-46) is available for use in servicing the Keyboard Switch logic and the Memory boards.

600-7. GENERAL PURPOSE INTERFACE CABLE (2200A-7006)

600-8. The General Purpose Interface Cable is designed for use in fabricating custom I/O cables for the Digital Input Option (-16) and the Alarm Set-Point Output Option (-23). The cable assembly consists of a 6-foot, 50-wire cable, and a 50-pin connector. The connector is attached to one end of the cable and is designed to mate with the rear-panel connectors on Options -16 and -23. The user is responsible for completing the connections at the free-end of the cable. Refer to the appropriate option (-16 or -23) in this section of the manual for the necessary connector pin assignments.

600-9. INTERFACE CONNECTOR (2200A-7007)

600-10. The Interface Connector is designed for use in fabricating custom I/O cables for the Digital Input Option (-16) and the Alarm Set-Point Option (-23). The connector assembly consists of a blank 50-pin connector and a hood. The user is responsible for the remainder of the cable. Refer to the appropriate option (-16 or -23) in this section of the manual for the necessary connector pin assignments.

600-11. FAN-FOLD PRINTER PAPER (2010A-7013)

600-12. Fan-fold paper suitable for use with the data logger's internal printer is available from the John Fluke Mfg. Co., Inc. The paper is supplied in packages containing one dozen packets. Therefore, when ordering, specify model number 2010A-7013 and indicate a quantity of 1 for each dozen packets required. (See Section 2 for paper installation instructions.)

600-13. PRINTER RIBBON (2010A-7014)

600-14. Two-color (red and black) printer ribbon suitable for use with the data logger's internal printer is available from the John Fluke Mfg. Co., Inc. The ribbon is supplied in packages containing one dozen spools. Therefore, when ordering, specify model number 2010A-7014 and indicate a quantity of 1 for each dozen spools required. (See Section 2 for printer ribbon installation instructions.)

Option -03
RTD Connector

603-1. INTRODUCTION

603-2. The RTD (Resistance Temperature Device) Connector (Option 2200A-03) is a card-edge connector assembly designed to function as the input connector for the 2240A-33 RTD Scanner or the 2200A-04 RTD Scanner. Four screw-type input connectors are provided for introducing either a three- or four-wire RTD input on each of 10 channels, 0 through 9. A separate common shield terminal is also available on the connector. The shield is connected internally to the data logger's measurement guard when 1 of the 10 channels is selected for measurement.

603-3. SPECIFICATIONS

603-4. Specifications for the 2200A-03 RTD Connector are given in Table 603-1.

603-5. INSTALLATION

603-6. The RTD Connector can be mounted in any one of the data logger scanner-block slots which contain an RTD Scanner. Install the connector as follows:

1. Unlatch the slide fasteners located on either side of the protruding enclosure at the rear of the data logger. Remove the enclosure from the rear panel.

2. Locate the desired scanner-block slot on the rear panel and check to ensure that an RTD Scanner is installed in the slot.

3. With the connector key toward the top, position the RTD Connector in the guides of the selected slot and mate it with the scanner's connector.

4. Install the retaining screws and washers that anchor the input connector to the data logger.

5. Install the rear panel enclosure.

603-7. INPUT CONNECTIONS

603-8. Figure 603-1 identifies the screw terminals provided for attaching RTDs to the input connector. Access to the terminals is accomplished by removing the four screws from the decal side of the connector enclosure. Spaces are provided on the decal for the user to record the connector's block and channel assignments for RTD inputs. Refer to the RTD Scanner manual (Option -04 or -33) for instructions concerning three- and four-terminal RTD connections.

Table 603-1. Specifications

Compatibility:	2200/2240 series data loggers
Input Terminals:	41 screw-type connections (HI, LO, +S, –S for each of 10 channels plus common shield).

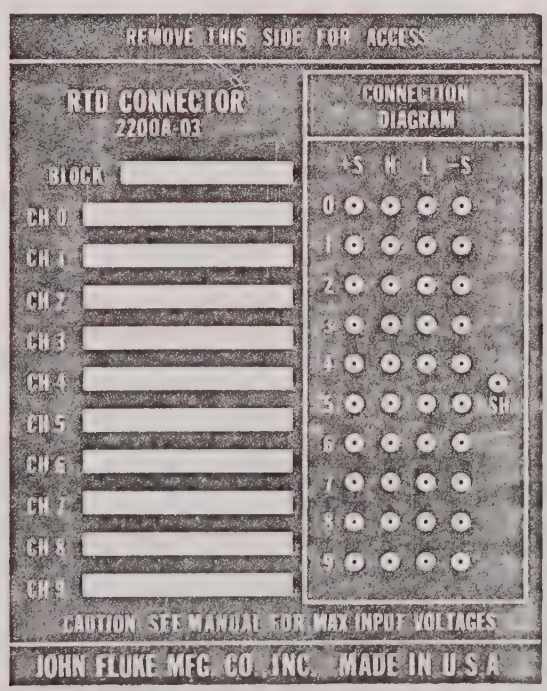


Figure 603-1. RTD Connector Terminal Assignments

603-9. LIST OF REPLACEABLE PARTS

603-10. Table 603-2 contains a list of replaceable parts for the RTD Connector. Refer to Section 5 of the data logger manual for ordering information.

Table 603-2. RTD Connector Assembly

ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
	RTD CONNECTOR ASSEMBLY (2200A-03) FIGURE 603-2						
H1	INSERT, CONNECTOR, POLARIZING	407254	54453	ISM-K1	1		
H2	RIVET, 4 X 1/2	272493	89536	272493	2		
H3	SCREW, 6-32 X 1/4	385401	89536	385401	41		
H4	SCREW, 6-32 X 1/4	152140	89536	152140	8		
H5	SCREW, 4-40 X 7/8	335133	89536	335133	1		
H6	WASHER, FLAT	146225	89536	146225	1		
H7	WASHER, FLAT	147728	89536	147728	2		
MP1	DECAL, RTD CONNECTOR	442780	89536	442780	1		
MP2	HOUSING, RTD CONNECTOR	414276	89536	414276	2		
MP3	TAPE, FOAM	424127	89536	424127	2		
P13	CONNECTOR, CARD-EDGE, 44-PIN	385674	89536	385674	1		

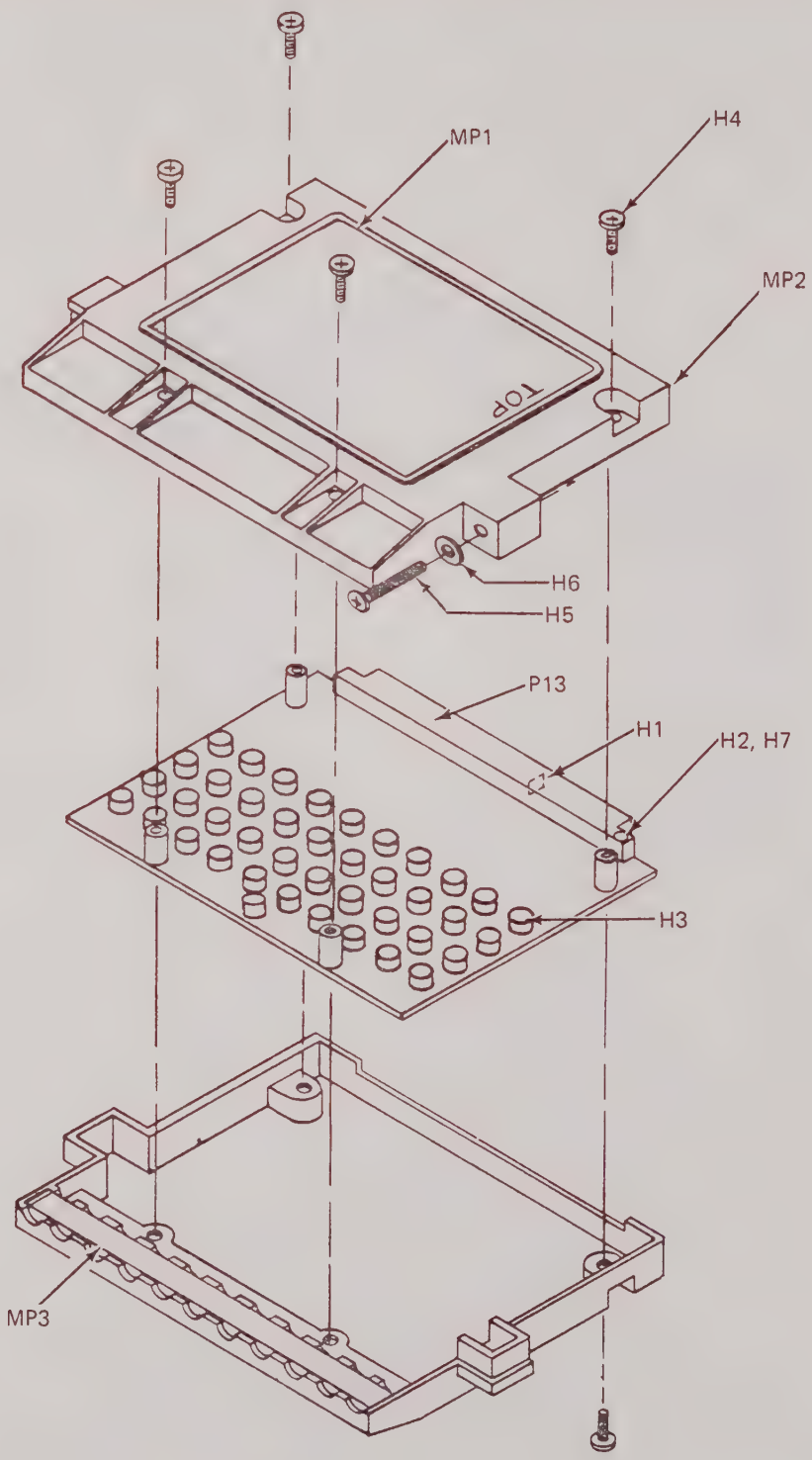
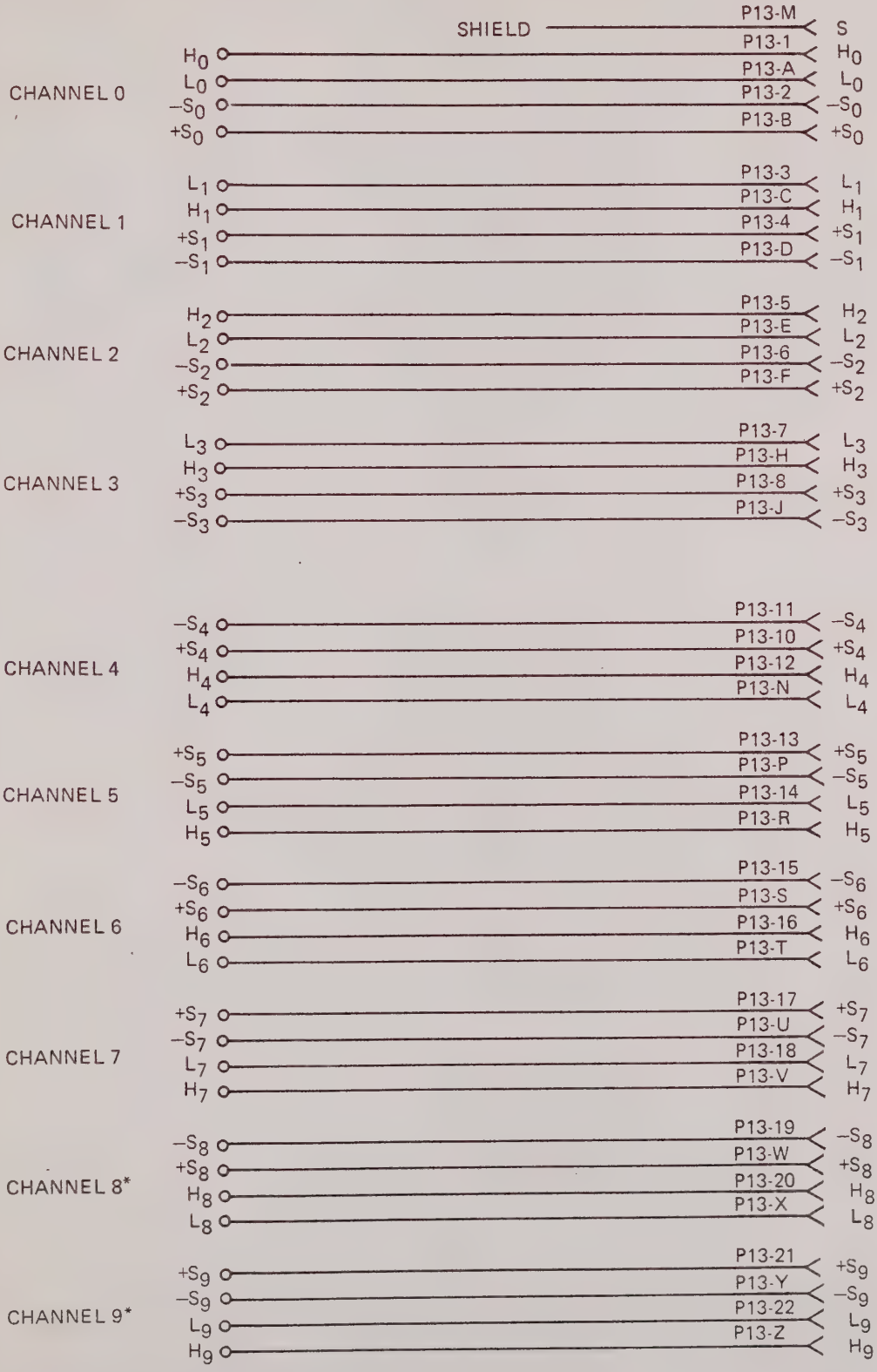


Figure 603-2. RTD Connector Assembly



* Not used with the 2240A-33 Scanners

Figure 603-2. RTD Connector Assembly (cont)

Option -05
General Purpose Scanner

605-1. INTRODUCTION

605-2. The General Purpose Scanner (Option -05) is a plug-in, 10-channel, 2-wire relay scanner designed to operate as a general purpose, analog data multiplexer in a 2200/2400 series data logger/scanner chassis (hereafter referred to collectively as data logger). Switched high and low inputs are provided for each of the 10 channels and a common (unswitched) shield is provided for all 10 channels. A decoupling relay is used to isolate the high, low, and shield buses from the common output connections when a channel relay is not activated. Activating any one of the 10 channel relays also energizes the decoupling relay.

605-3. SPECIFICATIONS

605-4. Specifications for the General Purpose Scanner are given in Table 605-1.

605-5. INSTALLATION

605-6. The General Purpose Scanner mounts in any one of the available scanner-block slots provided in the data logger, as shown in Figure 605-1. Install the scanner as follows:

WARNING

REMOVE LINE POWER AND ALL OTHER HIGH VOLTAGE INPUTS TO THE DATA LOGGER BEFORE STARTING THIS PROCEDURE.

1. Remove the top dust cover from the data logger.

2. Remove the large top inner cover located in the left rear of the unit (as viewed from the top front).

CAUTION

Handle the Scanner PCB by its edges to avoid contaminating the pcb with oil from the hands. The use of gloves is recommended.

3. Select the slot that includes the block of channels the scanner is to represent, and align the scanner in the slot so that the large board-edge connector is toward the rear of the unit, and the small offset board-edge connectors are toward the bottom of the unit. Push the scanner straight down onto

Table 605-1. Option -05 Specifications

Channel Relays	10 low thermal-emf reed relays
Poles Per Channel	Two (form A)
Shield Switching	One switch for 10 channels
Voltage Offset	≤10 μV
Input Voltage Limit* . .	170V dc or peak ac max
Common Mode Voltage Limit (Voltage between chassis and any input) .	350V dc or peak ac max provided the Input Voltage Limit is not exceeded

**Maximum voltage between any two terminals in the system. Includes normal mode as well as common mode voltages.*

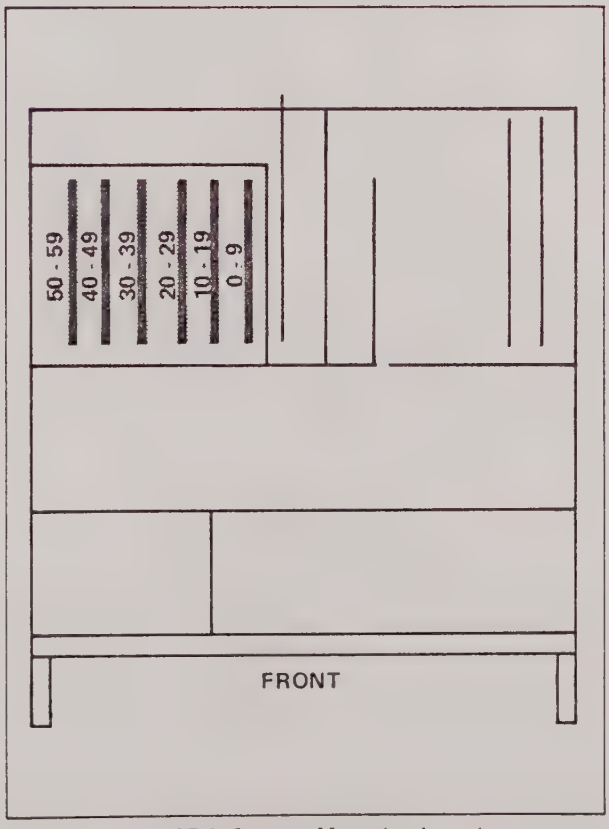


Figure 605-1. Scanner Mounting Locations

the mating connectors.

4. After the desired number of scanners is installed, install the large left rear inner cover.

5. Install the top dust cover.

605-7. OPERATION

605-8. Once installed in the data logger, the General Purpose Scanner requires no operator attention. However, certain considerations are necessary to properly interface the scanner with analog input data. These considerations are covered in the following paragraphs.

605-9. Input Connections

605-10. Analog interface connections with the General Purpose Scanner are completed through either one of two types of connectors, both of which are available as options. They include the Solder Pin Connector (Option -07) and the Isothermal Block Connector (Option -08). The Solder Pin Connector is a general purpose assembly which consists of a 44-pin connector with solder-type cable connections. A clam-shell housing provides strain relief for the cable, and protection of the connector contacts. The Isothermal Block Connector is required of the thermocouple inputs. It features an Isothermal Block with screw-type connections, and a temperature sensing circuit. Refer to the appropriate option subsection for additional information.

605-11. Input Pin Assignments

605-12. The pin assignments for the rear panel connector of the General Purpose Scanner are shown in Figure 605-2. Since contact with these signals is completed through one of two connector assemblies (Option -07 or -08), refer to the appropriate option subsection for pin assignments as available for fabrication interface cables.

NOTE

The guard connections shown in Figure 605-2 represent a unique potential within the data logger. Input shields should be connected to the Shield (pin 2), not to the guards.

605-13. THEORY OF OPERATION

605-14. The General Purpose Scanner, as shown in Figure 605-3, is a programmable, 10-channel relay scanner designed to operate as a plug-in option in any one of the scanner-block slots in a 2200/2240 Series Data Logger. Channel scanning or multiplexing is

TOP

L0	A	1	H0
GUARD	B	2	SHIELD
H1	C	3	L1
–	D	4	GUARD
L2	E	5	H2
GUARD	F	6	–
H3	H	7	L3
–	J	8	A/D COM.
TEMP. SIG.	K	9	6.2V dc (OUT)
BSL	L	10	REF. COM.
GUARD	M	11	–
L4	N	12	H4
–	P	13	GUARD
H5	R	14	L5
GUARD	S	15	–
L6	T	16	H6
–	U	17	GUARD
H7	V	18	L7
GUARD	W	19	–
L8	X	20	H8
–	Y	21	GUARD
H9	Z	22	L9

Lx = Low input to channel x.
Hx = High input to channel x.
Where: x = Block channel No. (0 - 9)
– = Not Used

Figure 605-2. General Purpose Scanner Rear Panel Pin Assignments

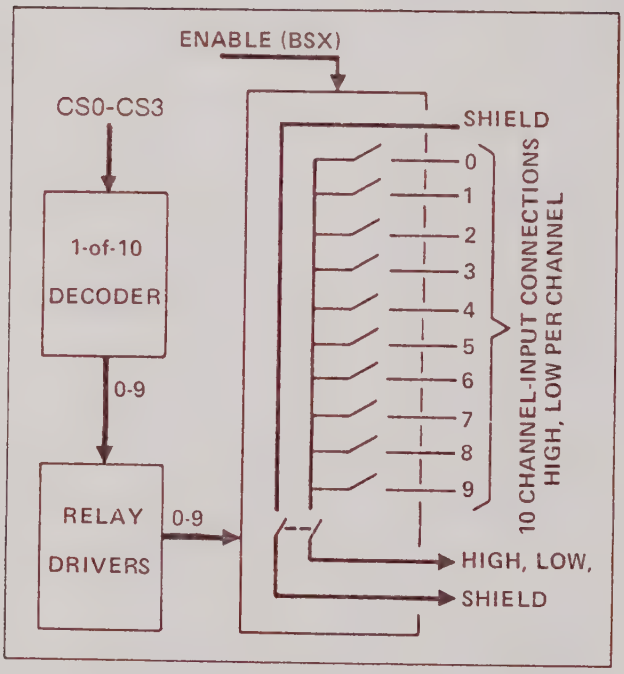


Figure 605-3. General Purpose Scanner, Functional Block Diagram

accomplished by a series of 12 form-A, reed relays; 11 are double-pole and 1 is single-pole. Ten of the double-pole relays serve as two-wire input channel switches ot a common high/low output bus. The eleventh two-pole relay also contacts the two-wire bus. However, its function is to isolate or decouple the Scanner Bus from the actual output connections. When any one of the channel relays is energized, the decoupling relay is also activated to complete the two-wire input/output circuit. The single-pole relay operates in parallel with the decoupling relay. When closed, it connects a common channel-input shield to the output shield connection. Thus, the scanner actually provides a three-wire output (high, low, and shield).

605-15. All scanner pcb's installed in a data logger receive bcd channel select information from a single Data Bus (CS0 through CS3). This data is decoded on each scanner pcb into 10 separate channel commands (0-9). Each channel line is first buffered and then connected to one of the 10 channel relay coils. Even though these commands are present, the relay will not be energized unless the scanner receives a scanner-block select (BSX) command. This command is actually an address or enable signal which applies voltage on the low side of the relay's coils. When the coil voltage is present the decoupling relay, the shield relay, and the selected channel relay will be energized. At that time, the analog input data on the selected channel appears at the scanner output terminals.

605-16. MAINTENANCE

605-17. Access Information

605-18. Refer to the installation information given in paragraph 605-6 for scanner access information. Remove the rear panel input connector before attempting to remove the scanner pcb from the data logger.

605-19. Performance Test

605-20. The performance test is designed to verify the overall operation of the General Purpose Scanner PCB Assembly and is intended for use as an acceptance test and/or periodic maintenance check. The equipment used in the test is specified in Table 605-2. If the scanner fails any part of the performance test, corrective action is required.

1. Using the resistors and the input connector specified in Table 605-2, fabricate a scanner test cable as shown in Figure 605-4.

2. Install the Low Level Scanner PCB in the channel 0-9 slot of the data logger.

3. Set the calibrator output to 0V dc.

Table 605-2. Required Test Equipment

INSTRUMENT	RECOMMENDED MODEL
DC Voltage Calibrator	Fluke 343A
Data Logger	Fluke 2200B/2240C
Input Connector	Fluke 2200A–07 or –08
Resistors (10 each)	Metal film, 1k ±1%, 1/4W

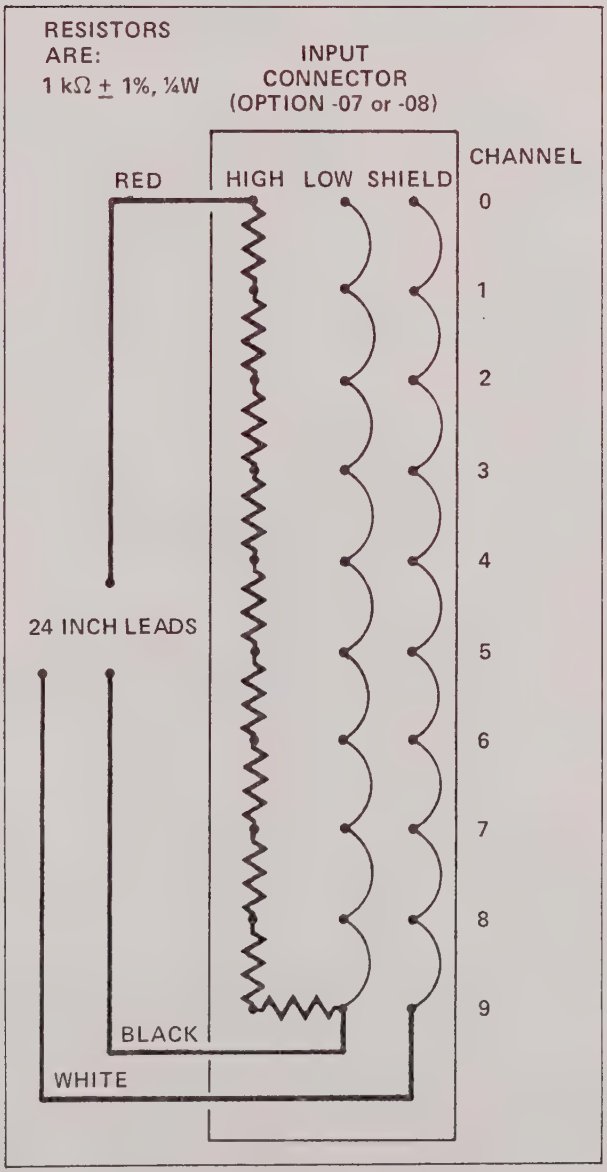


Figure 605-4. Scanner Test Cable

4. Connect the test cable leads to the calibrator's voltage output terminals (red to positive, black and white to negative).

5. Set the calibrator output to 1.000V dc.

6. Program the data logger as follows:

   a. First channel to 0.

   b. Last channel to 9.

   c. Each channel function to 4V.

   d. Press the ALL DATA (printer) switch in the OUTPUT CONTROL switch group.

7. Press the SINGLE scan switch and observe the printer measurement data. Channel 0 should read +1.000V dc ±1%. A cumulative +0.1V dc decrease should be observed at each of the remaining channels. (Channel 9 should read +0.1V dc.) Any deviation in this pattern indicates a defective pcb assembly.

605-21. LIST OF REPLACEABLE PARTS

605-22. A list of replaceable parts for the General Purpose Scanner PCB Assembly is given in Table 605-3. Refer to Section 5 of this manual for ordering information.

CAUTION

Indicated devices are subject to damage by static discharge.

TABLE 605-3 LIST OF REPLACEABLE PARTS NOT AVAILABLE

Option -06
Low Level Scanner

606-1. INTRODUCTION

606-2. The Low Level Scanner (Option -06) is a plug-in, 10-channel, 3-wire relay scanner designed to operate as a low-level, analog data multiplexer in a 2200/2240 Series Data Logger/Scanner Chassis (hereafter referred to collectively as data logger). Switched high, low, and shield inputs are provided for each of the 10 channels. A decoupling relay is used to isolate the high, low, and shield buses from the common output connections when a channel relay is not activated. Activating any one of the 10-channel relays also energizes the decoupling relay.

606-3. SPECIFICATIONS

606-4. Specifications for the Low Level Scanner are contained in Table 606-1.

606-5. INSTALLATION

606-6. The Low Level Scanner mounts in any one of the available scanner block slots provided in the data logger, as shown in Figure 606-1. Install the scanner as follows:

WARNING

REMOVE LINE POWER AND ALL OTHER HIGH VOLTAGE INPUTS TO THE DATA LOGGER BEFORE STARTING THIS PROCEDURE.

1. Remove the top dust cover from the data logger.

2. Remove the large top inner cover located in the left rear of the unit (as viewed from the top front).

CAUTION

Handle the scanner pcb by its edges to avoid contaminating the pcb with oil from the hands. The use of gloves is recommended.

3. Select the slot that includes the block of channels the scanner is to represent, and align the scanner in the slot so that the 44-pin board-edge connector is toward the rear of the unit, and the small offset board-edge connectors are toward the bottom of the unit. Push the scanner straight down onto the mating connectors.

Table 606-1. Option -06 Specifications

Channel Relays	10 low thermal-emf reed relays
Poles per Channel	Three (includes shield switch)
Shield Switching	One switch per channel
Voltage Offset	≤1 μV
Input Voltage Limit*	170V dc or peak ac max
Common Mode Voltage Limits (Voltage between chassis and any input)	350V dc or peak ac provided the Input Voltage Limit is not exceeded
Over-Current Protection	470Ω resistor in series with each input

**Maximum voltage between any two terminals in the system. Includes normal mode as well as common mode voltages.*

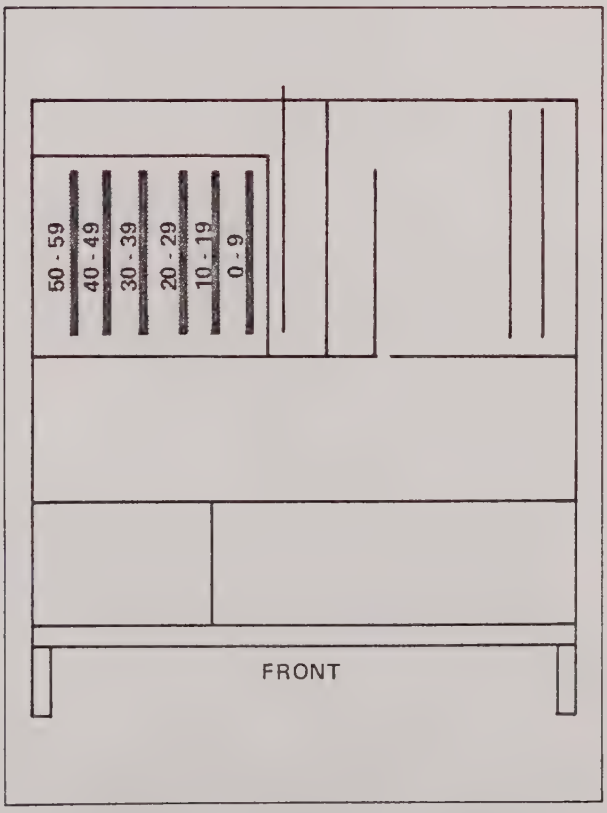


Figure 606-1. Scanner Mounting Locations

4. After the desired number of scanners is installed, install the large left rear inner cover.

5. Install the top dust cover.

606-7. OPERATION

606-8. Once installed in the data logger, the Low Level Scanner requires no operator attention. However, certain considerations are necessary to properly interface the scanner with analog input data. These considerations are covered in the following paragraphs.

606-9. Input Connections

606-10. Analog interface connections with the Low Level Scanner are completed through either one of two types of connectors, both of which are available as options. They include the Solder Pin Connector (Option -07) and the Isothermal Block Connector (Option -08). The Solder Pin Connector is a general purpose assembly which consists of a 44-pin connector mounted on a pcb. Solder-type cable connections are provided. A clam-shell housing provides strain relief for the cable and protection of the connector contacts. The Isothermal Block Connector is required for thermocouple inputs. It features an isothermal block with screw-type connections and a temperature sensing circuit. Refer to the appropriate option subsection for additional information.

606-11. Input Pin Assignments

606-12. The pin assignments for the rear panel connector of the Low Level Scanner are shown in Figure 606-2. Since contact with these signals is completed through one of two optional connectors (Option -07 or -08) refer to the appropriate option subsection for pin assignments as available for fabrication interface cables.

NOTE

The guard connections shown in Figure 606-2 represent a unique potential within the data logger. Input shields should be connected to the shield pins, not to the guard pins.

606-13. THEORY OF OPERATION

606-14. The Low Level Scanner, as shown in Figure 606-3, is a programmable, 10-channel relay scanner designed to operate as a plug-in option in any one of the scanner block slots in a 2200/2240 Series Data Logger. Channel scanning or multiplexing is accomplished by a series of 11 three-pole, form-A, reed relays.

TOP

L0	A	1	H0
GUARD	B	2	S0
H1	C	3	L1
S1	D	4	GUARD
L2	E	5	H2
GUARD	F	6	S2
H3	H	7	L3
S3	J	8	A/D COM.
TEMP. SIG.	K	9	6.2V dc (OUT)
BSL	L	10	REF. COM.
GUARD	M	11	S4
L4	N	12	H4
S5	P	13	GUARD
H5	R	14	L5
GUARD	S	15	S6
L6	T	16	H6
S7	U	17	GUARD
H7	V	18	L7
GUARD	W	19	S8
L8	X	20	H8
S9	Y	21	GUARD
H9	Z	22	L9

Sx = Shield for channel x.
Lx = Low input to channel x.
Hx = High input to channel x.
Where:x = Block channel no. (0-9)

Figure 606-2. Low Level Scanner Rear Panel Pin Assignments

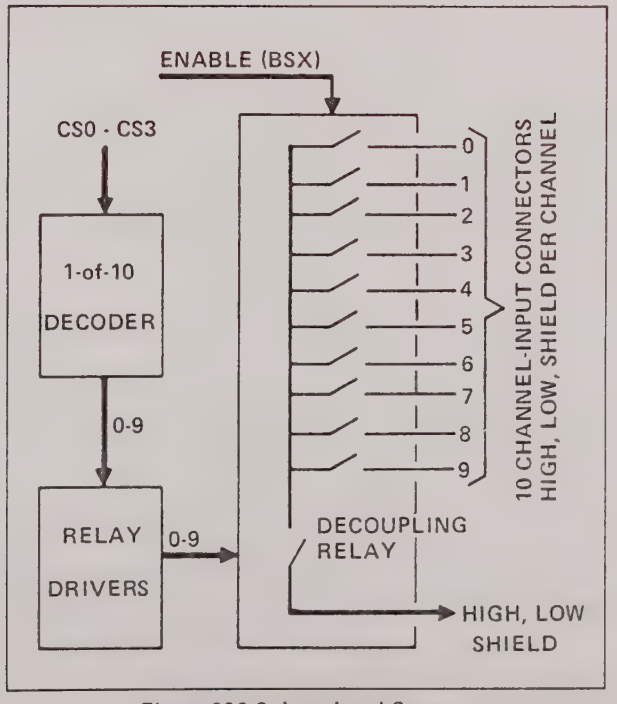


Figure 606-3. Low Level Scanner, Functional Block Diagram

Ten of the relays serve as three-wire input-channel switches to a common (high/low/shield) output bus. The eleventh relay also contacts the three-wire bus. However, its fuction is to isolate or decouple the Scanner Bus from the actual output connections. When any one of the channel relays is energized the decoupling relay is also activated to complete the three-wire input/output circuit.

606-15. All scanner pcb's installed in a data logger receive bcd channel select information in parallel from a 4-bit Data Bus (CS0 through CS3). This data is decoded on each scanner pcb into 10 separate channel commands (0-9). Each command line is first buffered and then connected to one of the 10 channel-relay coils. Even though these commands are present, the relays will not be energized unless the scanner receives a scanner-block select (BSX) command. This command is actually an address or enable signal which applies a control command to the low side of the relay coils. When this signal is present the decoupling relay and the selected channel relay will be energized. At that time, the analog input data on the selected channel appears at the scanner output terminals.

606-16. MAINTENANCE

606-17. Access Information

606-18. Refer to the installation information given previously for scanner access information. Remove the rear panel input connector before attempting to remove the scanner pcb from the data logger.

606-19. Performance Test

606-20. The performance test is designed to verify the overall operation of the Low Level Scanner PCB Assembly, and is intended for use as an acceptance test and/or periodic maintenance check. The equipment used in the test is specified in Table 606-2. If the scanner fails any part of the performance test, corrective action is required.

1. Using the resistors and the input connector specified in Table 606-2, fabricate a scanner test cable as shown in Figure 606-4.

2. Install the Low Level Scanner PCB in the channel 0-9 slot of the data logger.

3. Set the calibrator output to 0V dc.

4. Connect the test cable leads to the calibrator's voltage output terminals (red to positive, black and white to negative).

5. Set the calibrator output to 1.000V dc.

Table 606-2. Required Test Equipment

INSTRUMENT	RECOMMENDED MODEL
DC Voltage Calibrator	Fluke 343A
Data Logger	Fluke 2200B/2240C
Input Connector	Fluke 2200A–07 or –08
Resistors (10 each)	Metal film 1k ±1%, 1/4W

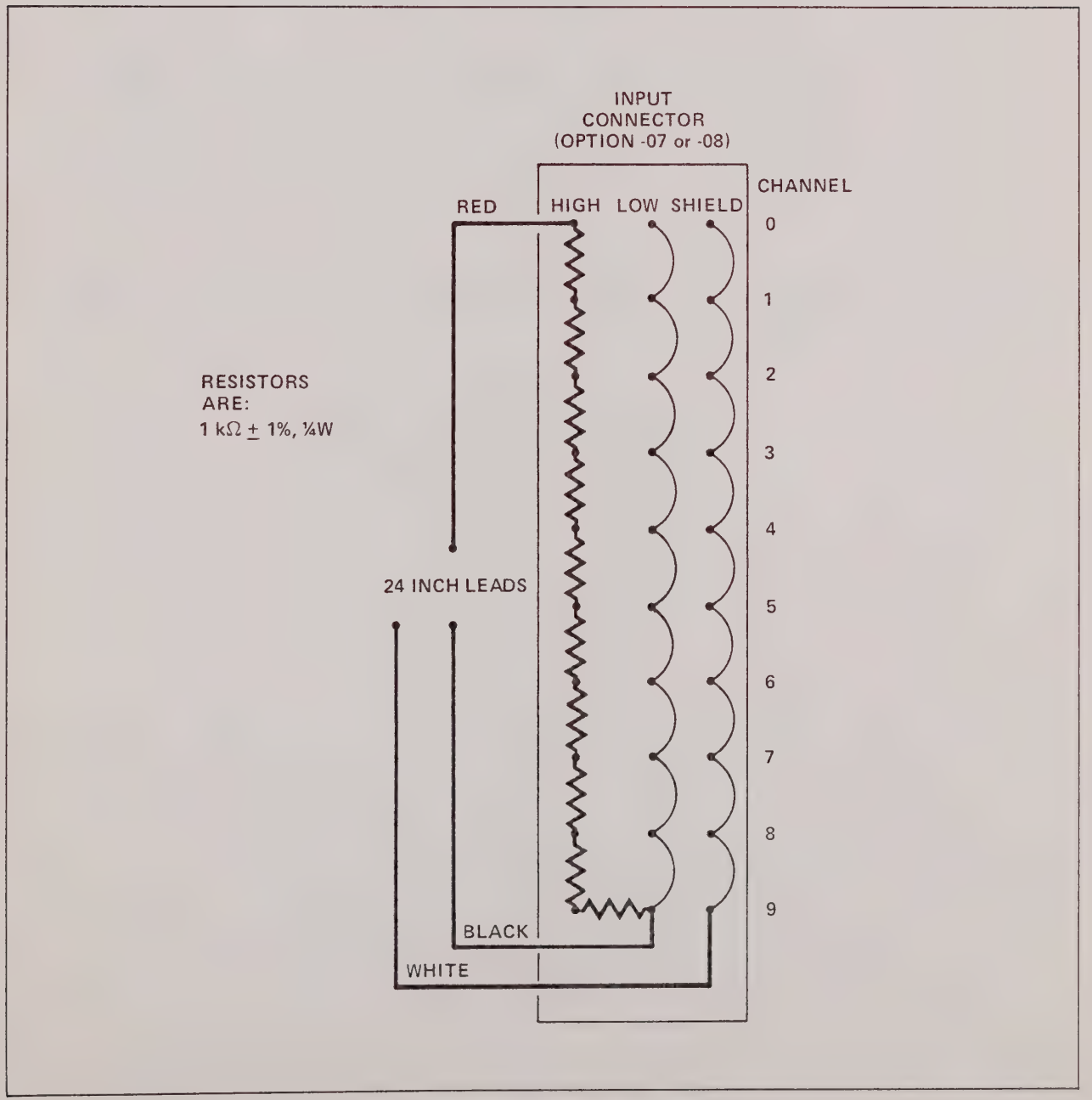


Figure 606-4. Scanner Test Cable

6. Program the data logger as follows:

   a. First channel to 0.

   b. Last channel to 9.

   c. Each channel fuction to 4V.

   d. Press the ALL DATA (printer) switch in the OUTPUT CONTROL switch group.

7. Press the SINGLE can switch and observe the printed measurement data. Channel 0 should read +1.000V dc ±1%. A cumulative +0.1V dc decrease should be observed at each of the remaining channels. (Channel 9 should read +0.1V dc.) Any deviation in this pattern indicates a defective pcb assembly.

606-21. LIST OF REPLACEABLE PARTS

606-22. A list of replaceable parts for the Low Level Scanner PCB Assembly is given in Table 606-3. Refer to Section 5 of this manual for ordering information.

CAUTION

Indicated devices are subject to damage by static discharge.

TABLE 606-3 LIST OF REPLACEABLE PARTS NOT AVAILABLE

Option -07
Solder Pin Connector

607-1. INTRODUCTION

607-2. The Solder Pin Connector (Option -07) is a general purpose connector assembly which mounts in the rear of the data logger and provides electrical contact with the analog inputs of either the General Purpose Scanner or the Low Level Scanner. The connector is designed for use in fabricating a custom interface cable to provide external analog inputs to a single relay scanner (10 analog channels).

607-3. The connector assembly consists of a 44-pin board-edge connector which is mounted on a pcb housed in a clam-shell enclosure. The enclosure separates from the assembly to provide assess to solder-type connections at the rear of the connector. Strain relief for the cable connections is provided by the enclosure.

607-4. SPECIFICATIONS

607-5. Specifications for the Solder Pin Connector are given in Table 607-1.

607-6. CABLE FABRICATION

607-7. Figure 607-1 identifies the connector pins and signals necessary to interface external analog input data with either the General Purpose Scanner or the Low Level Scanner. Assess to the solder-type terminals on the connector is accomplished by removing the four screws from the decal side of the connector enclosure. The decal identifies the pin connections and provides spaces for the user to uniquely identify the connector's block assignment and each of its channel inputs.

607-8. INSTALLATION

607-9. The Solder Pin Connector and cable assembly mounts in any one of the available scanner-block slots containing a scanner module. See Figure 606-2. Install the Solder Pin Connector as follows:

1. Using your fingers, unlatch the two slide fasteners located on either side of the protruding enclosure on the rear of the data logger. Remove the enclosure from the rear panel.

2. Locate the desired scanner-block slot on the rear panel and check to ensure that a scanner module is installed in the slot.

3. With the connector key toward the top, position the Solder Pin Connector in the guides of the selected

Table 607-1. Option -07 Specifications

Compatibility	Mates with either the -05 or -06 scanners
Terminal Style	Solder Type
Number of Terminals . .	30 (High, Low, Shield per channel)

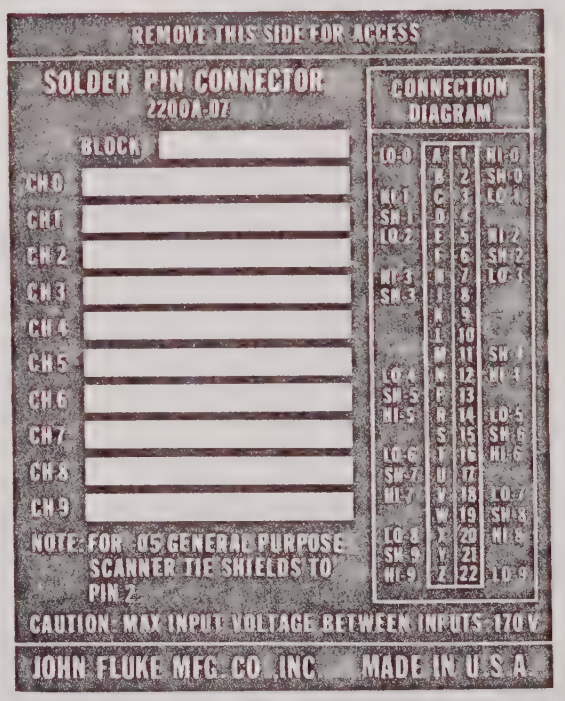


Figure 607-1. Solder Pin Connector Pin Assignments

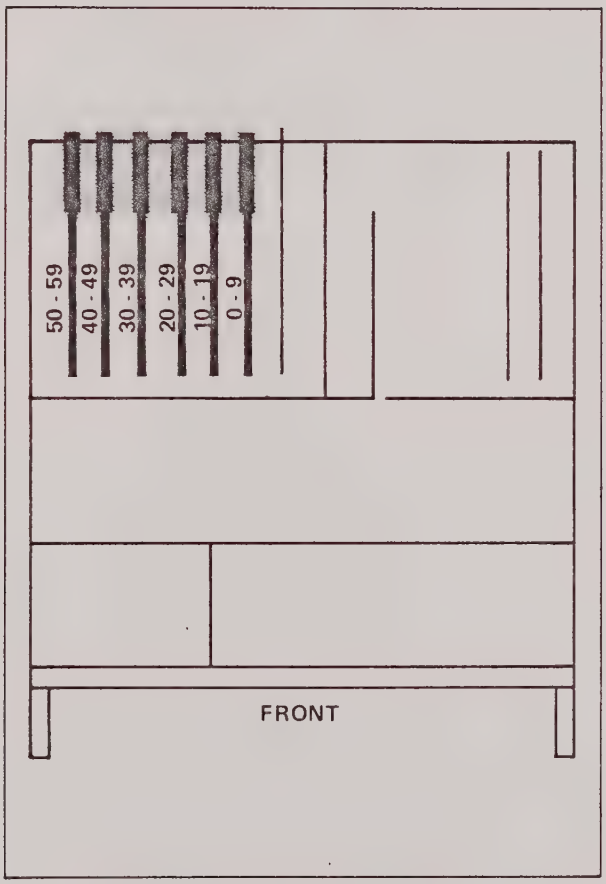


Figure 607-2. Solder Pin Connector
Mounting Locations

scanner block and mate it with the scanner's connector.

4. Install the retaining screws and washers that hold the input connector to the data logger.

5. After the required number of input connectors are installed, install the rear panel enclosure.

607-10. LIST OF REPLACEABLE PARTS

607-11. A list of replaceable parts for the Solder Pin Connector Assembly is given in Table 607-2. Refer to Section 5 of this manual for ordering information.

TABLE 607-2 LIST OF REPLACEABLE PARTS NOT AVAILABLE

Option -08
Isothermal Block Connector

608-1. INTRODUCTION

608-2. The Isothermal Block Connector (Option -08) is a 44-pin card-edge connector assembly designed for inputting low level thermocouple voltages and/or general purpose dc voltages to either the General Purpose Scanner (Option -05) or the Low Level Scanner (Option -06). Convenient screw-type input terminals are used to provide a fast and reliable method of completing the input connections. These terminals are thermally integrated into an isothermal block which is allowed to drift with ambient temperature. A temperature measuring circuit monitors the block temperature, and returns a proportional voltage to the data logger. This voltage is used by the data logger to calculate the temperature represented by each of up to 10 thermocouple-generated input voltages (i.e., one per channel). The temperature measuring feature does not interfere with ordinary voltage measurements.

608-3. SPECIFICATIONS

608-4. Specifications for the Isothermal Block Connector are given in Table 608-1.

608-5. INPUT CONNECTIONS

608-6. Figure 608-1 identifies the location of the high, low, and shield input terminals for each of the 10 scanner channels. Access to the terminals is accomplished by removing the four screws from the decal side of the connector enclosure. As input connections are completed, use the spaces provided on the connector decal to uniquely identify the connector's block (slot) assignment and each of its channel input signals.

608-7. INSTALLATION

608-8. The Isothermal Block Connector can be mounted in any one of the data logger scanner-block slots which contain a relay scanner (Option -05 or -06). See Figure 608-2. Install the connector as follows:

1. Using your finger, unlatch the slide fasteners located on either side of the protruding enclosure at the rear of the data logger. Remove the enclosure from the rear panel.

2. Locate the desired scanner-block slot on the rear panel and check to ensure that a scanner module is installed in the slot.

3. With the connector key toward the top, position the Isothermal Block Connector in the guides of the

Table 608-1. Option -08 Specifications

Compatibility	Mates with either the -05 or -06 scanners
Terminal Style	Screw Type
Number of Terminals . . .	30 (High, Low, Shield per channel
Temperature Gradient . . . between any terminals	±0.05°C maximum
Reference Junction Stability .	±0.005°C per ° (0°C to 50°C)

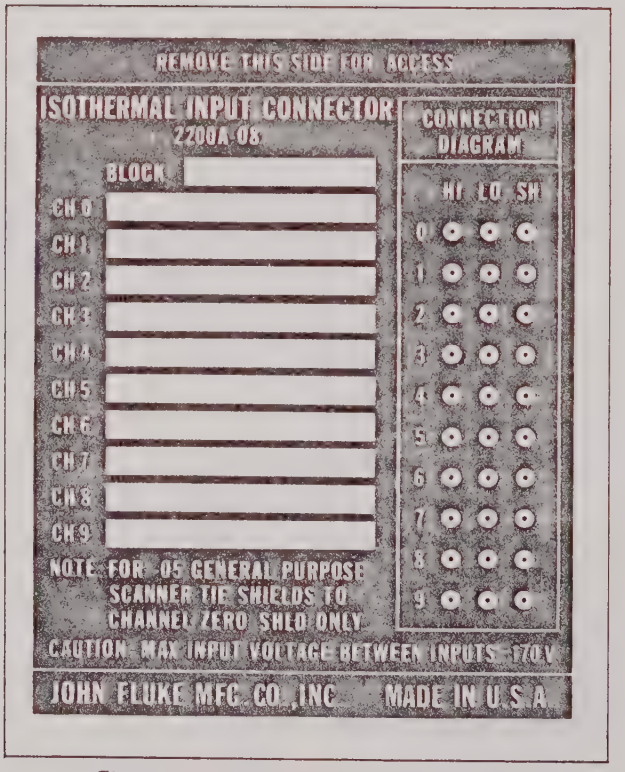


Figure 608-1. Isothermal Block Connector Terminal Assignments

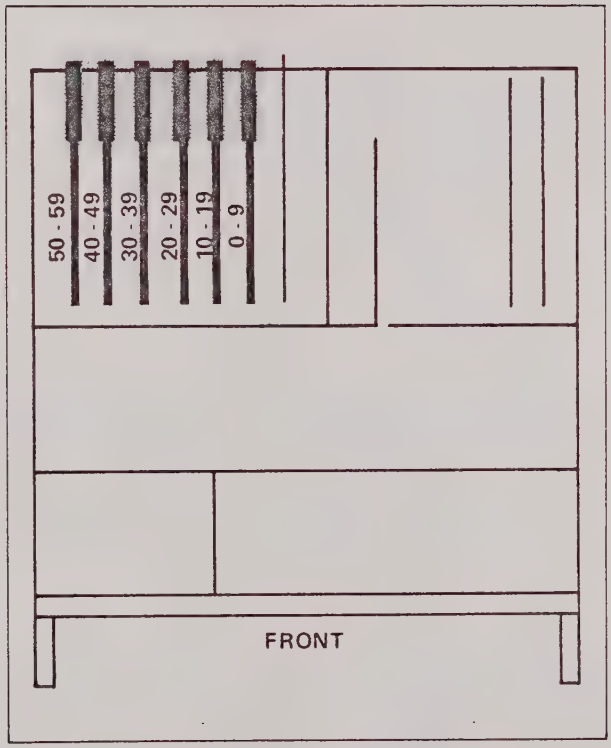


Figure 608-2. Isothermal Block Connector Mounting Locations

selected slot and mate it with the scanner's connector.

4. Install the retaianing screws and washers that hold the input connector to the data logger.

5. After the required number of input connectors are installed, install the rear panel enclosure.

608-9. OPERATION

608-10. Once installed, the Isothermal Block Connector requires no operator attention other than ensuring that the programmed function and/or range for each channel is compatible with the input signal source. For example, if the channel 0 input signal is derived from a thermocouple and a temperature reading is required, the programmed function must be in terms of temperature and thermocouple probe type (T1, T2, T3, or T4). Programming a voltage range in this case would be meaningless.

608-11. THEORY OF OPERATION

608-12. The Isothermal Block Connector provides the connections necessary for supplying voltage and/or (thermocouple) temperature inputs to any 10 scanner channels. Input connections are in the form of 10 sets of 3 screw terminals (high, low, and guard). The input signals at any given channel are measured in terms of voltage when a voltage function is programmed and in terms of temperature when a temperature function (T1, T2, T3, or T4) is programmed.

608-13. When a temperature function is programmed for a particular channel, it is assumed that a thermocouple probe (compatible with the selected function T1, T2, T3, or T4) is providing the input signal to that channel. Under these conditions the Isothermal Block Connector provides the microprocessor with the information necessary to compute the actual temperature at the thermocouple probe. This information includes the thermocouple voltage at the input terminals and a voltage indicative of the thermocouple input terminal temperature. The thermocouple input voltage is a direct result of the probe temperature versus the input terminal temperature. The input terminal temperature is measured by a separate sensing circuit and is electrically isolated from the thermocouple connections.

608-14. The temperature sensing circuit consists of a forward biased semiconductor junction which is thermally integrated into an anodized aluminum block. This block also surrounds and thermally integrates each of the 30 screw-type input terminals. The mass and temperature response of the block is such that the input terminal temperatures and the semiconductor sensor are held to within less than $\pm 0.05^{\circ}C$ of each other. Actual block temperature is allowed to vary with ambient temperature.

608-15. When a relay scanner is addressed the temperature sensing circuit provides the microprocessor with a voltage input proportional to the temperature of the isothermal block. This method of compensating a thermocouple reference junction is accurate over a temperature range of 0 to 50°C.

608-16. CALIBRATION

608-17. The temperature sensor on the Isothermal Block Connector has been calibrated at the factory and does not require periodic calibration to meet the specifications given in Section 1 However, calibration is required after the connector undergoes repair, or if the seal on the factory adjustment has been broken. The required equipment is listed in Table 608-2. Use the following procedure to calibrate the reference junction:

1. Calibrate the A/D Converter.

2. Install the Low Level Scanner (Option -06) in block 0 of the data logger.

3. Connect the thermocouple probe to the channel 4 terminals on the Isothermal Block Connector. Leave the terminal side of the connector cover off during the calibration procedure.

4. Attach the Isothermal Block Connector to the scanner in slot 0.

5. Prepare a room-temperature lag bath using the thermos bottle, and insert the thermometer and the thermocouple probe into the bath. (Allow the lag bath at least 15 minutes to stabilize.)

6. Energize the data logger and program it as follows:

   a. Set Monitor Channel to 4.

   b. Select temperature function (T1, T2, T3, or T4) that is compatible with the thermocouple probe.

   c. Depress the MONITOR scan control switch.

7. The data logger display should read the temperature of the lag bath as indicated by the mercury thermometer. If the display is in error, slowly adjust the pot on the Isothermal Block Connector while observing the display. The adjustment is correct when the display agrees with the thermometer reading and remains constant for at least 30 seconds.

Table 608-2. Equipment Required for Calibration

DESCRIPTION	RECOMMENDED MODEL OR TYPE
Data Logger	Fluke 2200B/2240C
Low Level Scanner	Fluke 2200A–06
Thermocouple Probe	Type J, K, or T (select type compatible with data logger being used)
Mercury Thermometer, 0.02°C Resolution	Princo ASTM-56C
Dewar Flask and Cap	1-pint Thermos Bottle

608-18. LIST OF REPLACEABLE PARTS

608-19. A list of replaceable parts for thhe Isothermal Block Connector is given in Table 608-3. Refer to Section 5 of this manual for ordering information.

TABLE 608-3 LIST OF REPLACEABLE PARTS NOT AVAILABLE

Option -09
General Purpose A/D Converter

609-1. INTRODUCTION

609-2. The General Purpose A/D Converter (Option -09) is a factory installed, plug-in pcb assembly that operates in conjunction with the Guard Crossing PCB Assembly to form a programmable, two-range (4V and 400 mV), dual-slope, a/d converter. Both ranges are programmed via the Guard Crossing and include a 40,000 count full-scale output capability. As a result, 10 uV can be accurately resolved on the 400 mV range.

609-3. When the General Purpose A/D Converter is used in conjunction with the Temperature and Scaling Option (-11), direct-reading thermocouple temperature measurements are possible. Temperature scales, selected via the data logger's front panel controls, permit measurement resolution of <WPSFLO: overstrike: +_>1°C or °F.

609-4. SPECIFICATIONS

609-5. Specifications for the General Purpose A/D Converter are given in Table 609-1.

609-6. OPERATIONS

609-7. Once installed in the data logger, the General Purpose A/D Converter requires no operator attention other than ensuring that the input voltages present at the measurement channels are compatible with the measurement function selected for the A/D Converter. Instructions for selecting range and function are contained in Section 2 of this manual.

609-8. THEORY OF OPERATION

609-9. General

609-10. The General Purpose A/D Converter PCB operates in conjunction with the Guard Crossing PCB to perform the analog functions of a two-range (400 mV and 4V), dual-slope integrating DVM capable of resolving 10 uV on the 400 mV range. Digital program and control data necessary to complete a measurement cycle (this includes the read clock) are generated on thhe Guard Crossing PCB. Similarly a 40,000 count counter string is included on the Guard Crossing for accumulating the digital equivalent of the measured analog input. After measurement data is accumulated it is presented to the Data Bus in character serial-format when solicited by the controller. A simplified block diagram of the General Purpose A/D Converter plus the associated digital logic from the Guard Crossing is given in Figure 609-1. A detailed schematic of the General Purpose A/D Converter PCB Assembly is shown in Figure 609-4.

TABLE 609-1, FIGURE 609-4 NOT AVAILABLE

609-11. Digital Control Logic

609-12. Digital control logic for the General Purpose A/D Converter is contained on both the Guard Crossing PCB and the A/D Converter PCB. A/D conversion logic on the Guard Crossing PCB consists of a crystal controlled clock, a digital counter with latches and multiplexed tri-state outputs, and dual-slope digital control logic. Digital logic on the General Purpose A/D Converter PCB consists of four addressable 4-bit registers and three output decoders. All digital input data utilized by the digital control logic is received from the controller via the Guard Crossing PCB Assembly.

609-13. Operation of the guard crossing logic is synchronized with the output of the crystal controlled clock. The clock, in turn, is synchronized with the line frequency to optimize the common mode and normal mode rejection characteristics of the a/d converter. This is accomplished by installing either a 2 MHz or 2.4 MHz crystal for 50 or 60 Hz line frequencies, respectively. Additional clock circuitry in the form of pulse shaping dividers produce the final 2<WPSFLO: overstrike: 0/> reference clock as received by the dual-slope control logic.

609-14. Overall timing of the dual-slope conversion process is goverened directly by the dual-slope control logic. Two control flip-flops (U14B/FFA and U20A/FFB) operate in response to the carry outputs of the various counter stages and the reference clock to determine the next state of the dual-slope control logic and, therefore, its output control signals. These signals are shown in Figure 609-2 and described in Table 609-2.

609-15. The data accumulated in the digital counter (if <WPSFLO: overstrike: <_>39999) is determined to be the digital equivalent of the analog input voltage when the DM (compare) input from the A/D Converter PCB transitions to a state which is the opposite of the POL (polarity) level. This transition indicates the end of the a/d conversion and causes the counter data to be loaded into the output latches. It also initiates a Data Ready signal which is transmitted across the guard as part of the status word.

609-16. When the controller detects the Data Ready status it generates a series of five Strobe In pulses which are converted on the Guard Crossing PCB into a series of five multiplexer pulses, MUX1 through MUX5. As each pulse sequentially occurs, one of the five 4-bit counter characters is solicited, transferred across the guard crossing, and placed onto the controller's Data Bus. The entire five measurement digits (this includes polarity and overload indications as part of the MSD) must be transmitted across the guard before the next measurement cycle is allowed to start (i.e., the reference clock is inhibited until MUX5 goes low to indicate that the last digit of measurement data has been solicited).

609-17. Channel select data for measurement purposes is updated

FIGURE 609-2, TABLE 609-2 NOT AVAILABLE

once during each a/d conversion (measurement) cycle so that new analog data can be presented to the a/d converter. Updating occurs in response to an interrupt status signal generated by the Guard Crossing PCB. The interrupt causes the controller to specify the next programmed measurement channel and its associated function data to the Guard Crossing PCB. Data is received as a series of four 4-bit characters which are serially transferred across the guard to the A/D Converter PCB. A unique strobe pulse (S1 through S4) accompanies each character and causes it to be entered into a 4-bit register. The first character is entered into a range and function register by strobe pulse S1. The second, third, and fourth characters are similarly entered into a series of three channel select registers by strobe pulses S2, S3, and S4, respectively.

609-18. Range and function data for the next measurement cycle are derived from the first stored character. Its two low-order bits D0 and D1 are decoded to provide the range command (4V or 400 mV) for the Range Amplifier on the A/D Converter PCB. similarly, open-thermocouple detect and reference-junction measure commands are decoded from the two high-order bits, D2 and D3.

609-19. Channel select commands (units, tens, and hundreds) are taken directly from the output of the three channel select registers. Tens data is decoded to provide the individual block select commands for the first 60 (0-59) channels in the data logger, while units data activates the appropriate channel relay (0-9) in the selected scanner block. Channel commands above 59 (60 through 999) are available at a rear-panel connector on the A/D Converter PCB for use in selecting channels maintained in an external scanner chassis (2201A, 2202A and/or 2203A).

609-20. Analog Circuit

609-21. The analog portion of the dual-slop A/D Converter is contained entirely on the General Purpose A/D Converter PCB Assembly. It consists of an input filter, a range amplifier, a reference supply, an integrator buffer, an integrator, a comparator, and a series of FET switches. Digital control signals from the Guard Crossing PCB control the operation of the FET switches and, therefore, the overall operation of the analog circuit. Figure 609-2 relates the operation of each individual FET switch to the digitally controlled measurement cycle.

609-22. Operation of any given measurement cycle can be logically divided into three measurement periods; auto zero, integrate, and read. Auto zero is used to measure and eliminate any in-circuit errors which might influence the end reading. During integrate the input signal is sampled (integrated) for a known time period. During the read period two separate functions are performed. The next analog input is applied to the input filter for settling purposes, and the previously sampled (integrate) input voltage is compared (integrated) against a

reference voltage. The time required to complete the read period is then translated, by the dual-slope control logic, into a digital equivalent of the analog input voltage.

609-23. The auto zero period begins at the end of the read period, as indicated by the leading edge of the Data Ready pulse. At that time, FET switches Q1, Q37, Q6, and Q9 are open and Q2, Q7, Q8, Q10 and Q12 are closed. Switch Q1 isolates the input of the range amplifier from the analog level present at the input filter. Switches Q2 and Q8 provide a zero volt reference levels for charging a series of reference capacitors C6, C7, and C8. Capacitor C6 charges through Q8 and Q12 to a value which is equal to the offset voltage error inherent in the Range Amplifier. Similarly, capacitor C8 is charged through switch Q10 to a value which is equal to the loop offset voltage of the integrator buffer, integrator and comparator combination. Finally, capacitor C7 is charged to the +2V reference level through switches Q7 and Q8. The charges on the capacitors will be retained throughout the remainder of the measurement cycle for use in eliminating offset errors (C6 and C8), and providing the choice of selectable reference polarity (C7) which is compatible with the analog input signal.

609-24. Termination of the auto zero period occurs in two steps. First switches Q2 and Q12 are opened and switch Q1 is closed. This isolates the range amplifier output from the rest of the circuit and allows it to respond to the input voltage applied through switch Q1. Second, switches Q7, Q8, and Q10 are opened and switch Q12 is closed. This connects the output of the range amplifier to the integrator buffer. At this time the auto zero period is ended and the integrate period begins.

609-25. During the integrate period the integrator buffer presents the integrator with an offset corrected dc input voltage which is equivalent to the analog input voltage level. This signal is then integrated for a fixed time which is equal to 20,000 read-clock pulses, as determined by the digital counters on the Guard Crossing PCB. When the time period is satisfied the integrate period is ended and the read period is started.

609-26. At the start of the read period switches Q1 and Q12 are opened, and Q2 and either Q6 or Q9 are closed. Switches Q1, Q2 and Q12 electrically remove the range amplifier and, therefore, the analog input signal from the input of the integrator buffer. If the input signal was positive, switch Q9 is closed and a -2 volt reference is applied to the integrator buffer via the previously charged reference capacitor C7. However, if the original analog input signal was negative, switch Q6 is closed causing the +2 volt reference to be applied directly to the input of the integrator buffer. In either event, integrator capacitor C9 begins to discharge at a fixed linear rate, and the counter string on the Guard Crossing PCB begins to count and accumulate the reference clock output. The discharge continues until the capacitor reaches a zero-charge level as determined by the

previous auto-zero period. When that level is detected by the comparator, a compare (CM) transition is generated to terminate the read period. This stops the counter on the Guard Crossing PCB and returns the analog cicuitry to the auto-zero period. (The next measurement cycle starts after data is transferred across the guard to the controller.)

609-27. Since the range amplifier and the input filter are isolated from the rest of the analog circuit at the beginning of the read period, both digital range data and the analog input signal for the next measurement channel are entered at that time. This allows both the input filter and the range amplifier to settle before the next measurement cycle begins.

609-28. MAINTENANCE

609-29. Access/Disassembly

609-30. The A/D Converter is accessed by removing the top dust cover, and the inner guard cover from the data logger. the position of the A/D Converter in the data logger is shown in Figure 609-3. Access to the calibration adjustments does not require the removal of the inner guard cover.

CAUTION

Handle the A/D converter PCB by its edges to avoid contaminating it with oil from the hands. The use of gloves is recommended.

609-31. To remove the A/D Converter from the data logger, remove the inner guard cover and disconnect the rear-panel scanner chassis cable which attaches to the data logger. (This cable is present only if the data logger is equipped with the Scanner Chassis, Model 2201A, 2202A, or 2203A.) Pull the A/D Converter PCB straight up and out through the top of the data logger.

609-32. Calibration

609-33. The General Purpose A/D Converter should be calibrated when the data logger is calibrated or after major repairs have been made to the pcb. A dc calibrator and a DVM are required for calibration. The recommended instruments are listed in Section 4, Table 4-1. The calibration adjustments and test points are all located on the A/D Converter PCB, and are shown in Figure 609-3. Use the following procedure to calibrate the A/D Converter:

CAUTION

Turn power off before removing or installing pcb's.

FIGURE 609-3 NOT AVAILABLE

1. De-energize the data logger and press the STOP/RESET switch in the SCAN CONTROL switch group.

2. Install a scanner pcb (Options -05 or -06) in scanner slot 0 of the data logger.

3. Set the output of the dc calibrator to 0V, and, using a Solder Pin Connector (Option -07), connect the output of the dc calibrator to channel 0 of the scanner in slot 0.

4. Energize the data logger and program it to perform the following scan sequence:

   a. Monitor Channel 00

   b. Funciton = 400 mV

5. Press the MONITOR switch and adjust the 400 mV ZERO pot (R7) for a zero indication, i.e., the display alternates between a + and - polarity indication. Ignore the digital display.

NOTE

Under normal conditions steps 6 through 10 may be omitted from the calibration procedure. However, if the A/D Converter has been repaired prior to calibration, component parts have been replaced, or potentiometer R50 has been inadvertently adjusted the steps must be executed.

6. Remove the inner guard cover.

7. Program the data logger for the 4V function and set the dc calibrator for a +1 mV output.

8. Adjust R50 for a display of 0.0010V.

9. Reverse the polarity of the dc calibrator output. The display should read -0.0010V.

10. Install the inner guard cover.

11. Set the output of the dc calibrator to 3.0000 volts, and adjust R12 for a reading of 3.0000 on the data logger display.

12. Reverse the polarity of the dc calibrator output. The dispaly should read -3.0000 ±0.0002V.

13. Set the dc calibrator output to +300 mV.

14. Program the data logger function to 400 mV and adjust R29 for a display of 300.00 mV.

609-34. LIST OF REPLACEABLE PARTS

609-35. A list of replaceable parts for the General Purpose A/D Converter PCB Assembly is given in Table 609-3. Refer to Section 5 of this manual for ordering information.

CAUTION

Indicated devides are subject
to damage by static dische.

TABLE 609-3 LIST OF REPLACEABLE PARTS NOT AVAILABLE

-12 Series
Teleprinter and RS-232-C Interface Options

612-1. SCOPE

612-2. The -12 Series Options include Option -12C, -12L and -12M and most are described in Section 1 of the data logger manual. Only the PROMs installed on the board change from one -12 series option to the next. A -12C option PROM is marked either T15700 P0 or T15700 P1; a -12L or M option PROM is marked either VTTY P0 or VTTY P1. Each option in the series is compatible with a commercially available teleprinter or RS-232-C compatible recorder. The information contained herein deals with the basic Digital Output PCB used to interface these recorders.

612-3. INTRODUCTION

612-4. The Digital Output PCB is designed to transfer bit-serial-character-serial data from the data logger to an external recording peripheral. This includes: Time-of-Day, Fixed Data, Digital Input Data (Option -16), and measurement data. The appropriate carriage-return and line-feed characters are also generated. Provisions are included for initiating a scan sequence using a remote start input.

612-5. A unique interface cable and a series of 24 switches on the pcb are used to tailor the digital output to the recorder. The cable is included as part of the option. The switches are set by the user to define recorder baud rate and data format.

612-6. The pcb used with the -12 Series Options is capable of operating as either an RS-232-C or a 20 mA current loop interface. For current loop operation a relay on the pcb opens and closes the loop for character transmission. The 20 mA current source must be resident in the teletypewriter.

612-7. Table 612-1 defines the configuration of each available option in the -12 Series, as well as its intended interface type: current loop or RS-232-C. Order by option number and description.

612-8. SPECIFICATIONS

612-9. Specifications for the -12 Series of options are given in Table 612-2.

612-10. INSTALLATION

612-11. Digital Output PCB

612-12. Up to three Digital Output PCB's can be mounted in the data loggers I/O slots, as shown in Figure 612-1. Install each -12 Series pcb as follows:

WARNING

Table 612-1. Configuration of –12 Series Options

OPTION NO.	DESCRIPTION	OPTION COMPONENTS (INDICATED BY ●)			INTERFACE TYPE	
		PCB	CABLE	RECORDER	20 mA	RS-232C
–12B	ASR-33 Interface	●	●		x	
–12C	TI733 KSR/RO Interface	●	●			x
–12L	RS-232C General Purpose Terminal Interface	●	●			x
–12M	RS-232C General Purpose Modern Interface	●	●			x

Table 612-2. –12 Series Option specifications

Compatibility	Specify at time of purchase, using alphabetic suffix as shown in Table 617-1
Output Format	Bit-serial
Output Levels	20 mA dc current loop (–12B) and EIA Standard RS-232C (–12C, –12L, –12M, –12N)
Output Code	ASCII 7-level (no parity bit)
Measurements per Line	1 through 16, switch selectable
Word Format	Unwanted word blocks may be deleted by switches on pcb. Word order cannot be changed
Record Format	CR, LF (Carriage Return, Line Feed) Time-of-Day (days, hrs., min., s) CR, LF CR, LF (not in –12C), fixed Data, CR, LF Digital Inputs CR, LF (–16 Option) Channel, limit, sign, data , range, function, CR, LF
Baud Rate	
RS-232-C	110, 300, 1200, 2400, 4800 (Switch selectable)
20 mA Current Loop	110
–12C	110, 300

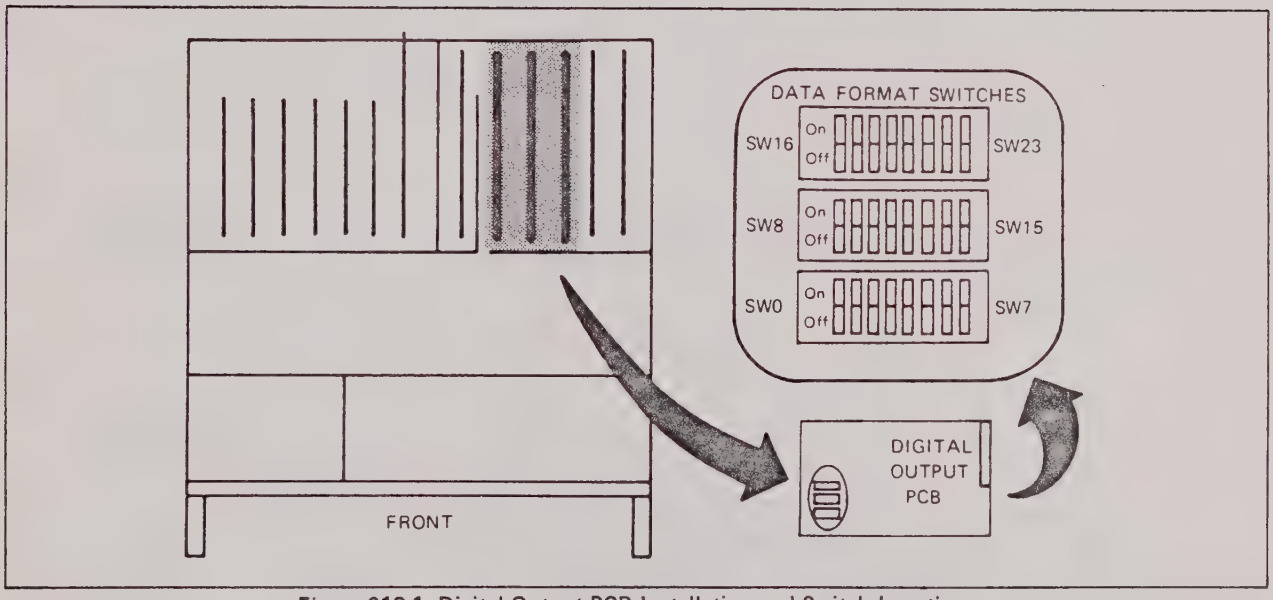


Figure 612-1. Digital Output PCB Installation and Switch Locations

REMOVE LINE POWER AND ALL OTHER HIGH VOLTAGE INPUTS TO THE DATA LOGGER BEFORE STARTING THIS PROCEDURE.

1. Set the data logger POWER switch to OFF.

2. Remove the top dust cover from the data logger.

3. Remove the inner, unguarded cover and locate the Data Format switches on each -12 Series Digital Output PCB, as shown in Figure 612-1.

4. With reference to Figure 612-2, establish the format of recorded data as follows:

   a. Set switches 0 through 11 to OFF. This establishes the format shown in Figure 612-2.

   b. Delete any combinations of unwanted character segments by setting the assigned switches to ON.

   c. Set the desired baud rate using switches 16 through 19.

   d. If a teletype or CRT is used to record data, set switches 12 through 15 to the desired number of readings per line minus 1. For example, a setting 0000 is equal to 1 reading per recorded line. The total number of characters and space per line cannot exceed the number of columns available on the teletype or CRT (80 typical).

NOTE

Set unused switches (SW20-SW23) to OFF.

5. Align each Digital Output PCB in its selected I/O slot so that the large female connector is toward the rear of the data logger, and the small board-edge connector is toward the bottom of the unit. Push the pcb straight down onto the mating connector.

6. After the Digital Output PCB(s) is (are) installed, install the top covers.

612-13. Interface Cable

612-14. The interface cable supplied with the Digital Output PCB

DETAILS OF RECORDED DATA

DESCRIPTION	RECORDED DATA FORMAT AND CONTROL SWITCH (0 thru 11) ASSIGNMENTS *
START OF SCAN	CR LF
TIME OF YEAR (2240C ONLY)	D D D : H H : M M : S S CR LF SW 0 — SW 1
FIXED DATA (2240C)	NOT ON –12C CR LF SP SP FD FD FD FD FD FD CR LF SW 2 — SW 3
DIGITAL INPUT DATA (Option –16)	AC AC SP DD DD DD DD DD DD DD DD DD CR LF
MEASUREMENT DATA –NORMAL	CH CH CH > < SP ± AD AD AD . AD AD m SP SP V C F CR SP LF SP SW4 — SW5 SW6 SW7 SW8 SW9 SW10 — SW11 Floating Decimal Point MEASUREMENT UNITS
MEASUREMENT DATA –ABNORMAL	CH CH CH SP SP SP O B L T SP SP SP m SP V C F CR LF OVERLOAD BROKEN THERMOCOUPLE MEASUREMENT UNITS

BAUD RATE AND LINE LENGTH SWITCHES (12 thru 23)

The binary code entered is equivalent to one less than the number of recorded measurements per teleprinter line prior to CR LF, EXAMPLE: 0000=1 measurement per line.

SWITCHES	NOT USED 20	21	22	23	BAUD RATE 1 = ON 16	17	18	19	1=ON 12	13	14	15
110=					1	1	1	1	8	4	2	1
300=					1	1	0	1				
1200=					1	0	1	1				
2400=					1	0	0	1				
4800=					0	1	1	1				

*MNEMONICS

AC	=	Address Code
AD	=	Analog Data
CH	=	Channel Number
CR	=	Carriage Return
D	=	Day Code
DD	=	Digital Input Data
FD	=	Fixed Data
H	=	Hours
LF	=	Line Feed
M	=	Minutes
S	=	Seconds
SP	=	Space

Figure 612-2. Recorded Data Format and Digital Output PCB Switch Assignments

is designed to interface a specific recording device (see Section 1 of the data logger). If data logger scan sequences are to be initiated manually using the front-panel switches, connect the interface cable between the Digital Output PCB's rear-panel connnector and the appropriate recorder. If the scan sequences are to be initiated by a remote input, complete the following procedure prior to connecting the interface cable:

1. Remove approximately 2 inches of the sleeving covering the data logger end of the cable, behind the connector.

2. Seperate the three wires outside the main cable, under the sleeving.

3. Identify each wire, using an Ohmeter.

   a. Pin 31 - Start

   b. Pin 6 - Scan in Progress

   c. Pin 48 - Logic Common

4. Install the interface cable and connect the remote control lines to the desired source. The function of each line is described below:

   a. START - If the REMOTE switch in the data logger's SCAN CONTROL switch group is depressed, a contact closure to Logic Common or a low TTL/DTL logic level will initiate a scan sequence. If a scan is in progress, the Start input is ignored.

   b. SIP (Scan in Progress) - This TTL output goes low to indicate that a scan is in progress. Start inputs during this period are ignored. SIP also goes low when REMOTE is pressed, and will remain low until an external START is received and the first scan sequence is completed.

   c. LOGIC COMMON - Logic common for the start input and SIP output signals.

NOTE

If a single remote control source is used and more than one Digital Output PCB is installed, it is sufficient to complete the remote control connections on only one interface cable.

612-15. OPERATION

612-16. Once installed in the data logger, the Digital Output PCB requires no operator attention. Instructions for connecting the remote control lines are given earlier under Installation. Refer to the appropriate teleprinter/cassette-recorder instruction manual for additional recorder information.

612-17. The timing required to initiate a remote start depends upon the data logger's configuration and its current activities. Assuming that the REMOTE SCAN CONTROL switch is depressed and an EXTERNAL ENABLE switch is depressed (Preferably ALL DATA) the following conditions will assure a start of scan.

1. Apply a momentary contact closure to ground or a low logic level to the Start input (31). If SIP (6) is initially low (prior to start input), allow the first scan sequence to complete. SIP will return high at the end of the sequence, and will go low for subsequent scan sequences.

2. While the Scan in Progress output is high (i.e., no keyboard or front panel activity) a negative-going Start pulse with a width of >-5 ms will cause a remote start.

3. Under worst case keyboard activity, a Start pulse >-100 ms is required to ensure a remote start.

4. If the Start input is held low from the start to finish of a scan sequence, a second scan will be initiated. A continuous scan mode is achieved by holding the Start input low.

612-18. THEORY OF OPERATION

612-19. The Digital Output PCB, as shown in Figure 612-3, is a microprocessor based subsystem which functions as a controller peripheral to provide the interface necessary to transfer data logger time-of-day, digital data, heading, and measurement data (as printed on the internal printer) to an external digital recording device. Any one of several types of recorders can be accommodated by the interface. Among these are: a 20 mA current-loop teleprinter (-12 Options), a paper tape punch (-13 Options), an incremental magnetic tape recorder (-14 Options), or any RS-232-C compatible recording device (-12 Options). Once the recorder is defined, the interface pcb can be tailored to meet the interface requirements by the addition of two plug-in ROM's and an interface cable (both are supplied as an integral part of the option). Additional formatting and baud rate requirements (when applicable) are manually selected using a series of 24 switches located on the pcb. (See installation instructions for switch settings as they apply to this option.) Provisions are

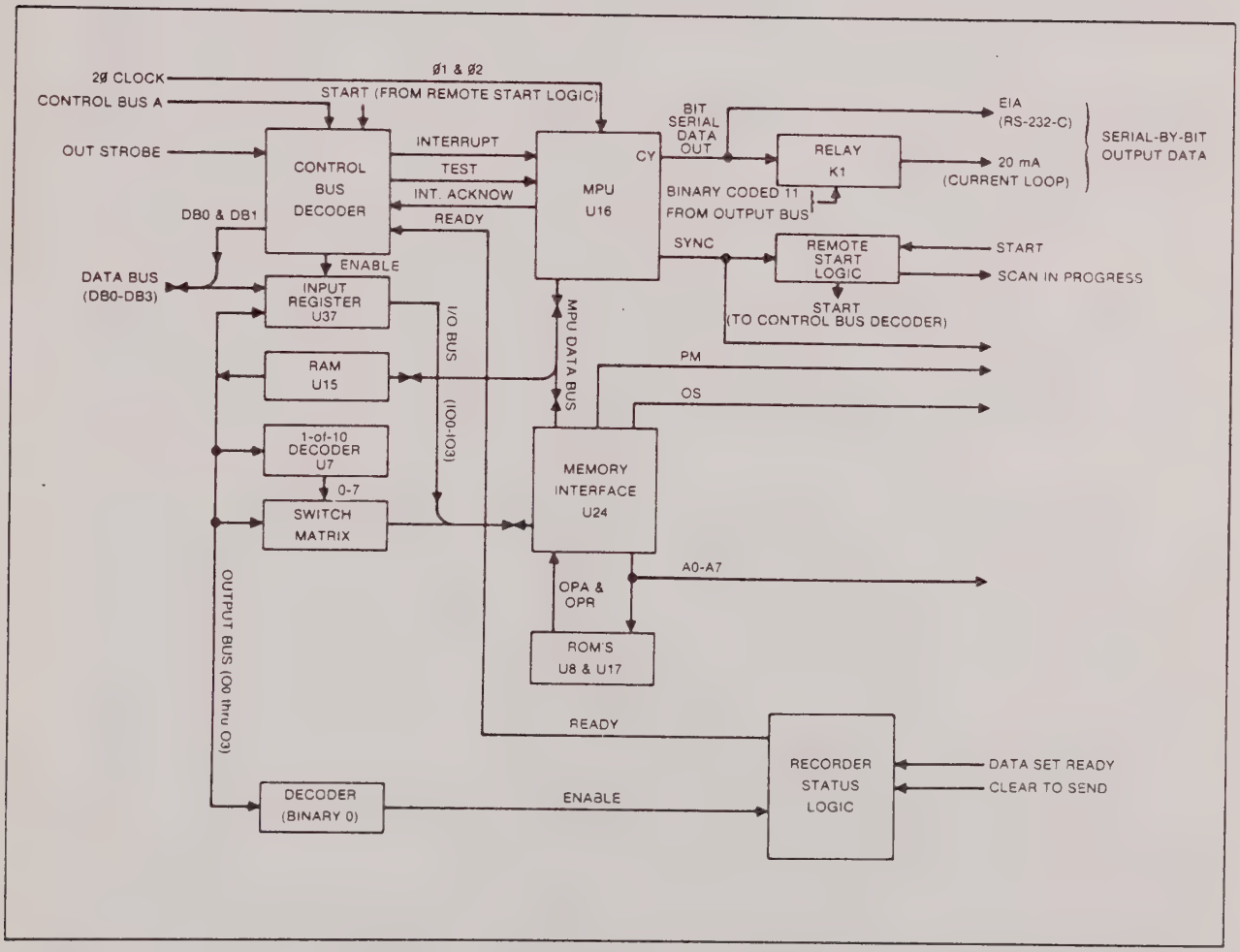


Figure 612-3. Digital Output PCB Simplified Block Diagram

also included which allow a contact closure to ground (or any other low-level input) to serve as a remote start-of-scan signal to the data logger. While a scan is in progress (SIP) an SIP output is generated to indicate that subsequent start inputs will not be accepted until the current scan sequence has been completed.

612-20. Data transfer from the controller to the external recorder is accomplished in two operations: first, an input transfer sequence, and then, an output transfer sequence. The input transfer sequence is executed under the direction of the controller and includes the character-serial transfer of 16 4-bit characters from the controller (via the Data Bus) to a storage location (RAM) on the Digital Output PCB. After the input transfer is complete, the microprocessor on the Digital Output PCB directs the execution of the output transfer sequence. That is, the transfer of data from the storage location to the recording device. Appropriate handshaking is employed to ensure the output transfer is synchronized with the recorder.

612-21. When the controller is ready to initiate a data transfer it interrogates the status of the Digital Output PCB by placing a binary coded 6 onto Control Bus A. A decoder on the pcb detects the 6 and initiates an appropriate status response via the Data Bus. Table 612-3 lists the possible responses and their meanings.

612-22. Upon receiving a binary coded 3 (11) as a status response, the controller initates the data transfer sequence by simultaneously placing a binary coded 4 onto Control Bus A, and the first data character (4-bits) onto the Data Bus. A Control Bus Decoder detects the control character (binary coded 4) and responds by generating an Interrupt to the MPU and an Input-Enable to the 4-bit Input Register. On the rising edge of the accompanying Out Strobe, the Test input to the MPU is driven high and the character on the Data Bus is entered into the Input Register. As a result of the high Interrupt and Test inputs, the MPU generates a low Interrupt Acknowledge output which is used to provide a Busy response. (Busy is used in the event the status of the output pcb is interrogated prior to completing the entire data transfer to the peripheral device, see Table 612-3.) At the same time the MPU causes the output RAM to place a binary coded 8 onto the Output Bus. The presence of this code plus a subsequent IS pluse (generated by the Memory Interface) enables the contents of the Input Register to be read (via the I/O Bus) by the Memory Interface. On the trailing edge of the IS pulse the MPU's Test input is returned low to complete the first character segment of the 16-character input-transfer sequence.

612-23. Since the binary coded 4 is still present on the Control Bus, the character-serial transfer of data between the controller and the Memory Interface continues, as previously described, until an entire block of 16 characters has been processed. As each character of input data is read by the System Interface it is also transferred through the MPU (via the MPU Data Bus) into

Table 612-3. Description of Status Response Codes

Status Response		Meaning of Status Response
DB1	DB0	
0	0	Remote Start commanded but transfer in progress. Wait until not Busy.
0	1	Remote Start. Initiate a scan sequence.
1	0	Busy. Data transfer in progress. No action required.
1	1	Initiate a data transfer sequence.

the RAM.

612-24. After the controller presents the last input character to the Digital Output PCB it removes the binary coded 4 from Control Bus A. With the control code gone, the Interrupt input to the MPU goes low to inhibit additional data from being entered into the input register. This completes the initial phase (input data transfer) of the data transfer sequence.

612-25. The output transfer sequence begins as the MPU writes a binary coded 0 onto the Output Bus. A decoder detects the zero and issues an Enable input to the Recorder Status Logic. If the external device is ready to receive data, the Recorder Status Logic will provide a low Ready output which drives the MPU's test input high to indicate that an output transfer may commence. Since the Digital Output PCB is capable of transferring output data in a bit-serial-by-character format, as well as a bit-parallel-by-character format, each process will be considered separately.

612-26. Bit parallel output data is stored, one character at a time, in a pair of 4-bit output registers. Data transfer to the registers is enabled by the PM input from the Memory Interface, and is entered on the leading edge of the OS pulse. As PM goes low the first output character, including 4-bits of supplementary data (ASCII, BCDIC, and/or EBCDIC), is placed onto address lines A0 through A7. After the character is entered by the subsequent OS pluse, the PM output is returned high. This PM transition arms the Write Punch Logic to allow the rising edge of the next Sync pulse to initiate a Write/Punch output pulse. An appropriate amount of time later a second OS pulse is issued, and the write/punch output is terminated on the trailing edge of the next Sync pulse. As each bit-parallel character appears on the output lines (D0 through D7) a Parity Generator provides a ninth bit (jumper selectable odd or even) for parity.

612-27. The bit serial output is enabled when the MPU instructs the RAM to place a binary coded 11 onto the Output Bus. Output data is then taken a bit at a time from the MPU's CY output and used to drive an EIA output buffer as well as relay K1. The mercury-wetted contacts of K1 are used to provide a current loop interface (contact closure for a 20 mA current loop).

612-28. The format of output data is established by the setting of 24 rocker switches which comprise a 3 X 8 switch matrix (see Figure 612-3). These switches are scanned at the beginning of each output transfer sequence by the MPU (via the RAM Output Bus) and read into the Memory Interface as six 4-bit characters. To read each character the MPU causes the RAM to sequentially place binary coded numbers 0 through 5 onto the Output Bus. A 1-of-10 decoder detects each number, and effectively scans the matrix switches in groups of four. Thus, each closed switch within a scanned group causes a low level to be placed onto the normally high I/O Bus. (Isolation diodes are provided with each switch to

avoid interaction between the various groups of matrix switches.) As each 4-bit word appears on the I/O Bus, it is read into the Memory Interface (by an IS pulse).

612-29. The transfer of output data, regardless of format, must be synchronized with the interface recorder. This is accomplished by the Recorder Status Logic which detects and reacts to a series of handshaking routines. For example, Ready and Punch input/outputs are used to synchronize the operation to a paper tape punch. Similarly, RS-232-C compatible recorders employ the Data-Set-Ready and Clear-to-Send inputs. Magnetic tape recorders utilize the Ready and Write lines to record data, and the EOR (End-Of-Record) and Gap-in-Progress lines to initiate (EOR) a standard inter-record gap, and to indicate its duration (Gap-in-Progress).

612-30. The Remote Start Logic, upon receipt of an external Start command, alters the Digital Output PCB's status response so as to initiate a data logger scan sequence (see Table 612-3). An acceptable start input is a >_5 ms contact closure to ground while the Scan-in-Progress output is high. When the controller interrogates the Status of the Digital Output PCB (binary coded 6 on Control Bus A) the Remote Start Logic provides a start scan response via the Control Bus Decoder. During the following data transfer sequence the controller includes both a start-of-scan (binary coded 8) and an end-of-scan (binary coded 9) character with the normal data transfer characters. These two characters are decoded by the 1-of-10 decoder, and used to initiate and terminate the Scan-in-Progress (SIP) output. While the SIP output is active all start inputs are ignored.

612-31. MAINTENANCE

612-32. Access Information

612-33. Refer to the installation instructions given earlier in Digital Output PCB access information. Remove the rear panel output connector before attempting to remove the pcb from the data logger.

612-34. Performance Test

612-35. The Digital Output PCB Assembly is most easily tested under normal operating conditions. That is, installed in a functional data logger and interfaced with the recording device it normally drives. Output data format and characters can then be checked by comparing data recorded on the internal printer with hard copy data derived from the external recording device.

612-36. LIST OF REPLACEABLE PARTS

612-37. The lists of replaceable parts for the -12 Series of data logger options are given in Tables 612-4, -5, and -6. Refer to Section 5 of the data logger manual for ordering information.

TABLES 612-4,-5, and -6 LISTS OF REPLACEABLE PARTS NOT AVAILABLE

CAUTION

Indicated devices are subject to damage by static discharge.

-13 Series
Paper Tape Punch and Cassette Recorder Interface Options

613-1. SCOPE

613-2. The -13 Series Options include Options 13A through 13E, and are described in Section 1 of the data logger manual. Each option in the 13A through 13C series is compatible with the Facit Model 4070 Paper Tape Punch, and the PROMs installed are marked PTAPE P0, or PTAPE P1. Option 13C and 13D are compatible with Facit Model 4203.0005 Cassette Tape Recorder , and the PROMs installed are marked SP1 P0 or SP1 P1. The information contained herein deals with the Digital Output PCB used to interface these recording devices. Option configurations for Series -13 are defined in Table 613-1.

613-3. INTRODUCTION

613-4. The Digital Output PCB is designed to transfer character-serial/bit-parallel data from the data logger to either an external paper tape punch (Facit Model 4070) or an Incremented Interface Recorder. This includes: Time-of-Day, Fixed Data, Digital Input Data (Option -16), and measurement data. The appropriate carriage-return and line-feed characters are also generated. Provisions are included for initiating a scan sequence using a remote start input.

613-5. A special interface cable and a series of 24 switches located on the pcb are used to tailor the pcb's digital output with the external recorder's digital inputs. The cable is included as part of the option and the user manually sets the switches to define the format of the recorded data. Provisions are included on the pcb for selecting either odd or even parity.

613-6. SPECIFICATIONS

613-7. Specifications for the -13 series of options are given in Table 613-2.

613-8. INSTALLATION

613-9. Digital Output PCB

613-10. Up to three Digital Output PCB's can be mounted in the data loggers I/O slots, as shown in Figure 613-1. Install each output pcb as follows:

WARNING

REMOVE LINE POWER AND ALL OTHER HIGH VOLTAGE INPUTS TO THE DATA LOGGER BEFORE STARTING THIS PROCEDURE.

Table 613-1. –13 Series Options Specifications

Compatibility.....Designed to interface the data logger output with the Facit Model 4203.0005. Specify requirements at time-of-purchase using alphabetic suffix as shown in Table 1-2.

Output Format.....Bit-parallel/Character-serial

Output Code.....ASCII 8-level including jumper selectable parity bit.

Output Level.....TTL compatible.

Measurements per Line.....1 through 16, switch selectable.
(–13A through –13C)

Characters per Record.....1 through 256, switch selectable.
(–13D through –13E)

Word Format.....Unwanted word blocks may be deleted by switches on PCB. Word order cannot be changed.

Record Format.....@, CR, LF (Carriage Return, Line Feed)
Time-of-Day (day, hr, min) CR,LF
Digital Inputs, CR, LF (–16 Option)
Channels, limit, sign, data, range, function, CR, LF

Table 613-2. Description of Status Response Codes

Status Response		Meaning of Status Response
DB1	DB0	
0	0	Remote Start commanded but transfer in progress. Wait until not Busy.
0	1	Remote Start. Initiate a scan sequence.
1	0	Busy. Data transfer in progress. No action required.
1	1	Initiate a data transfer sequence.

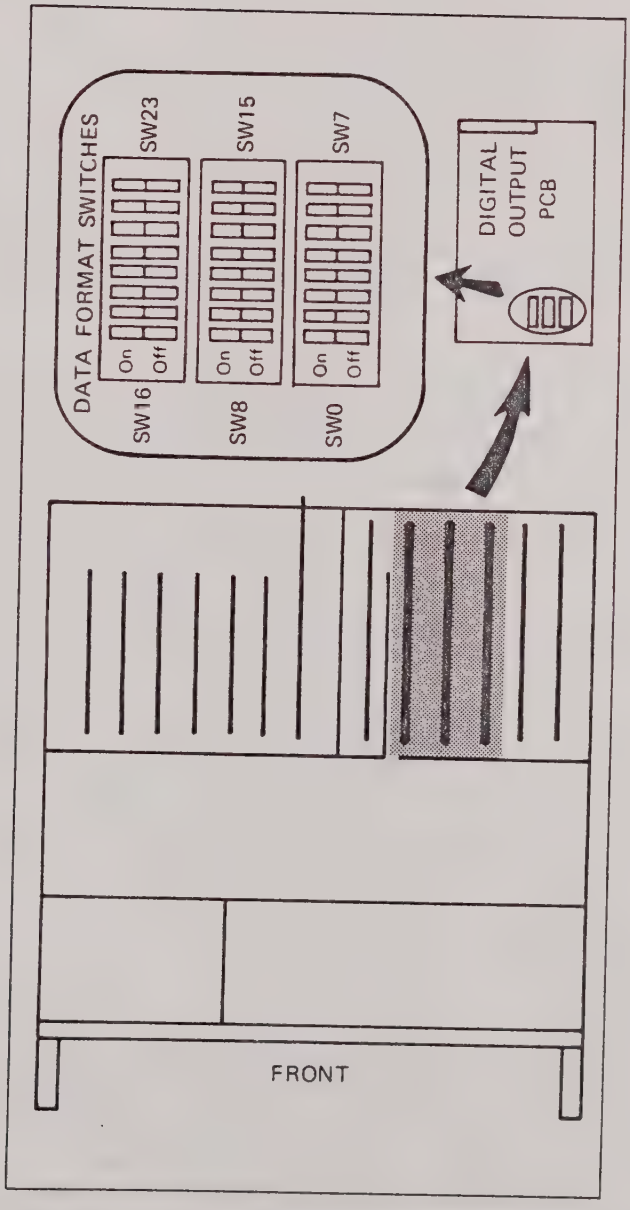


Figure 613-1. Digital Output PCB, Installation and Switch Locations

1. Set the data logger POWER switch to OFF.

2. Remove the top cover from the data logger.

3. Locate the Data Format switches on each Digital Output PCB as shown in Figure 613-1.

4. With reference to Figure 613-2, establish the format of recorded data as follows:

   a. Set switches 0 through 11 to OFF. This establishes the format shown in Figure 613-2.

   b. Delete any combination of unwanted character segments by setting the appropriate switches to ON.

   c. Refer to Figure 613-2 and set switches 12 through 15 for either the desired number of readings per line (paper tape punch interface) or the desired number of characters per record (incremental cassette tape recorder).

   d. Set unused switches (16 through 23 or 20 through 23) to OFF.

5. Refer to Figure 613-3 and position the jumpers desired odd or even parity.

6. Align the Digital Output PCB in the selected I/O slot so that the large female connector is toward the rear of the data logger, and the small board-edge connector is toward the bottom of the unit. Push the pcb straight down onto the mating connector.

7. After the Digital Output PCB(s) is (are) installed, install the top cover.

613-11. Interface Cable

613-12. The interface cable supplied with the -13 Series Option is designed to interface the Digital Output PCB with the specified recorder: Model 4070 Paper Tape Punch or Model 4203.0005 Cassette Tape Recorder. If the data logger scan sequences are to be manually initiated using the front panel SCAN CONTROL switches, connect the interface cable between the Digital Output PCB's rear-panel connector and the appropriate recording device. If the scan sequences are to be initiated by a remote input signal, complete the following procedure prior to connecting the interface cable.

1. Remove approximately 2 inches of the sleeving covering the data logger end of the cable, behind

DETAILS OF RECORDED DATA

DESCRIPTION	RECORDED DATA FORMAT AND CONTROL SWITCH (0 thru 11) ASSIGNMENTS*
START OF SCAN	@ CR LF
TIME OF YEAR (2240C ONLY)	D D D : H H : M M : S S CR LF SW 0 → SW1
FIXED DATA (2240C)	CR LF SP SP FD FD FD FD FD FD CR LF SW2 → SW3
DIGITAL INPUT DATA (Option–16)	AC AC SP DD DD DD DD DD DD DD DD DD CR LF
MEASUREMENT DATA –NORMAL	CH CH CH SP SP AD AD AD · AD AD m SP SP V C F CR SP LF SP Floating Decimal Point SW4 SW5 SW6 SW7 SW8 SW9 SW10 SW11 MEASUREMENT UNITS
MEASUREMENT DATA –ABNORMAL	CH CH CH SP SP SP O B L T SP SP SP m SP V C F CR LF OVERLOAD BROKEN THERMOCOUPLE MEASUREMENT UNITS

OPTIONS –13A thru –13C
RECORDED MEASUREMENTS PER LINE SWITCH SETTINGS(12 thru 15)

Set switches to indicate, in binary, one less than the desired maximum number of recorded measurements per teleprinter line prior to CR LF. For example, 0000= one measurement recorded per teleprinter line. 1=ON

NOT USED — SETTINGS INDICATE MEASUREMENTS PER LINE +1

	20	21	22	23	16	17	18	19	12	13	14	15
SWITCHES												
BINARY EQUIVALENT	—	—	—	—	—	—	—	—	2^3	2^2	2^1	2^0
DECIMAL EQIVALENT	—	—	—	—	—	—	—	—	8	4	2	1

OPTIONS –13D and –13E
CHARACTERS PER RECORD SWITCH SETTINGS(12 thru 19)

Set switches to indicate, in binary, one less than the maximum number of recorded characters per scan sequence. For example, a binary coded 199 is equal to 200 recorded characters per scan sequence 1= ON

NOT USED — SETTINGS INDICATE CHARACTERS PER RECORD +1

	20	21	22	23	16	17	18	19	12	13	14	15
SWITCHES												
BINARY EQUIVALENT	—	—	—	—	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
DECIMAL EQIVALENT	—	—	—	—	128	64	32	16	8	4	2	1

*MNEMONICS

AC	=	Address Code
AD	=	Analog Data
CH	=	Channel Number
CR	=	Carriage Return
D	=	Day Code
DD	=	Digital Input Data
FD	=	Fixed Data
H	=	Hours
LF	=	Line Feed
M	=	Minutes
S	=	Seconds
SP	=	Space

Figure 613-2. Recorded Data Format and Digital Output PCB Switch Assignments

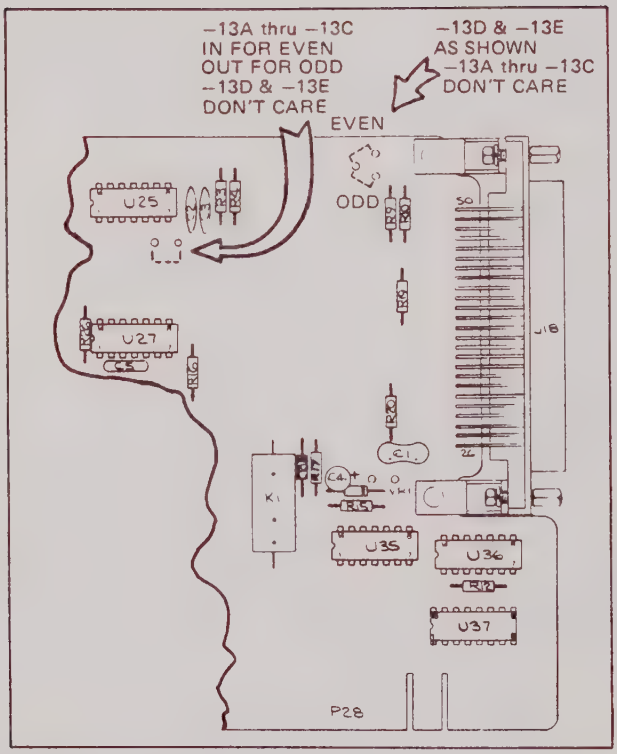


Figure 613-3. Even Parity Jumper Location, –13 Series Options

the connector.

2. Seperate the three wires outside the main cable, under the sleeving.

3. Identify each wire, using an Ohmeter.

   a. Pin 31 - Start

   b. Pin 6 - Scan in Progress

   c. Pin 48 - Logic Common

4. Feed the three wires through the cable port in the connector hood and reassemble the connector.

5. Install the interface cable and connect the remote control lines to the desired control source. The function of each line is described below:

   a. START - If the REMOTE switch in the data logger's SCAN CONTROL switch group is depressed, a contact closure to Logic Common or a low TTL/DTL logic level will initiate a scan sequence. If a scan is in progress, the Start input is ignored.

   b. SIP - A TTL output that goes low to indicate that a scan is in progress. Start inputs during this period are ignored. SIP also goes low when REMOTE is pressed, and will remain low until an external START is received and the first scan sequence is completed.

   c. LOGIC COMMON - Logic common for the Start input and the SIP output signals.

NOTE

If a single remote control source is used and more than one Digital Output PCB is installed, it is sufficient to complete the remote control connections on only one interface cable.

613-13. OPERATION

613-14. Once installed in the data logger, the Digital Output PCB requires no operator attention. Instructions for connecting the remote control lines are given under Installation. Refer to the Facit Instruction Manual for details concerning the external recording device.

613-15. The timing required to initiate a remote start depends upon the data logger's configuration and its current activities. Assuming that the REMOTE SCAN CONTROL switch is depressed and an EXTERNAL ENABLE switch is depressed (preferable ALL DATA) the following conditions will assure a start of scan:

1. Apply a contact closure to ground or a low logic level to the Start input (31). If SIP (6) is initially low (prior to start input) allow the first scan sequence to complete. SIP will return high at the end of the sequence, and will go low for subsequent scan sequences.

2. While the Scan in Progress output is high (i.e., no keyboard or front panel activity) a negative-going Start pulse with a width of >-5 ms will cause a remote start.

3. Under worst case keyboard activity, a Start pulse, >-100 ms is required to ensure a remote start.

4. If the Start input is held low from the start to finish of a scan sequence, a second scan will be intiated. A continuous scan mode is achieved by holding the Start input low.

613-16. THEORY OF OPERATION

613-17. The Digital Output PCB, as shown in Figure 613-4, is a microprocessor based subsystem which functions as a controller peripheral to provide the interface necessary to transfer the data logger time-of-day, digital data, heading, and measurement data (as printed on the internal printer) to an external digital recording device. Any one of several types of recorders can be accommodated by the interface. Among these are: a 20 mA current-loop teleprinter (-12 Options), a paper tape punch (-13 Options), an incremental magnetic tape recorder (-14 Options), or any RS-232-C compatible recording device (-12 Options). Once the recorder is defined, the interface pcb can be tailored to meet the interface requirements by the addition of two plug-in ROM's and an interface cable (both are supplied as an integral part of the option). Additional formatting and baud rate requirements (when applicable) are manually selected using a series of 24 switches located on the pcb. (See Installation instructions for switch settings as they apply to this option.) Provisions are also included which allow a contact closure to ground (or any other low-level input) to serve as a remote start-of-scan signal to the data logger. While a scan is in progress (SIP) and SIP output is generated to indicate that subsequent start inputs will not be accepted until the current scan sequence has been completed.

613-18. Data transfer from the controller to the external

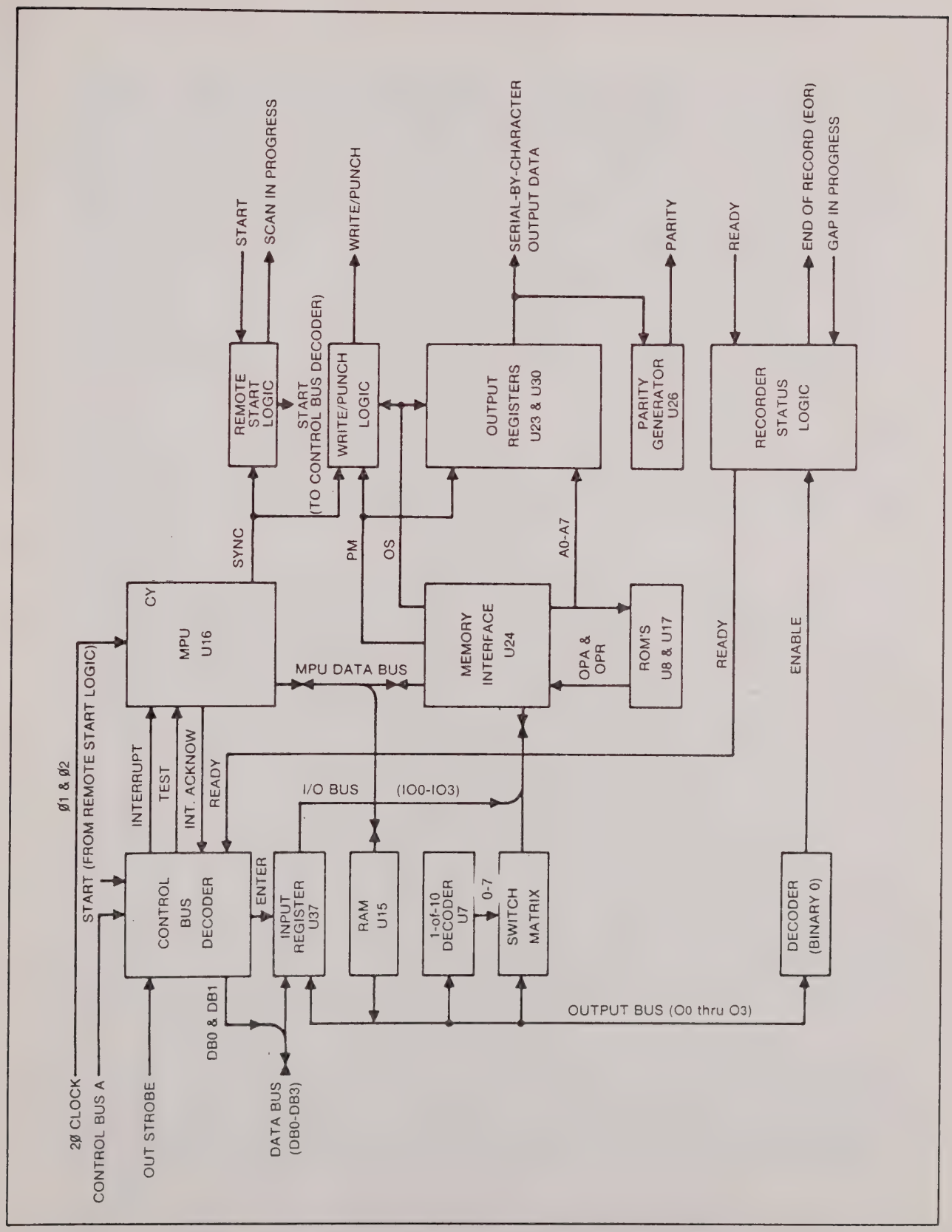


Figure 613-4. Digital Output PCB Simplified Block Diagram

recorder is accomplished in two operations: first, an input transfer sequence, and then, an output transfer sequence. The input transfer sequence is executed under the direction of the controller and includes the character-serial transfer of 16 four-bit characters from the Controller (via the Data Bus) to a storage location (RAM) on the Digital Output PCB. After the input transfer is complete, the microprocessor on the Digital Output PCB directs the execution of the output transfer sequence. That is, the transfer of data from the storage location to the recording device. Appropriate handshaking is employed to ensure the output transfer is complete, the microprocessor on the Digital Output PCB directs the execution of the output transfer sequence. That is, the transfer of data from the storage location to the recording device. Appropriate handshaking is employed to ensure the output transfer is synchronized with the recorder.

613-19. When the controller is ready to initiate a data transfer, it interrogates the status of the Digital Output PCB by placing a binary coded 6 onto Control Bus A. A decoder on the PCB detects the 6 and initates an appropriate status response via the Data Bus. Table 613-2 lists the possible responses and their meanings.

613-20. Upon receiving a binary coded 3 (11) as a status response, the controller initiates the data transfer sequence by simultaneously placing a binary coded 4 onto Control Bus A, and the first data character (4 bits) onto the Data Bus. A Control Bus Decoder detects the control character (binary coded 4) and responds by generating an interrupt to the MPU and an input-Enable to the 4-bit Input Register. On the rising edge of the accompanying Out Stobe, the Test input to the MPU is driven high and the character on the Data Bus is entered into the Input Register. As a result of the high interrupt and test inputs the MPU generates a low Interrupt Acknowledge output which is used to provide a Busy response. (Busy is used in the event the status of the output pcb is interrogated prior to completing the entire data transfer to the peripheral devices, see Table 613-3.) At the same time the MPU causes the output RAM to place a binary coded 8 onto the Output Bus. The presence of this code plus a subsequent IS pulse (generated by the Memory Interface) enables the contents of the Input Register to be read (via the I/O Bus) by the Memory Interface. On the trailing edge of the IS pulse the MPU's Test input is returned low to complete the first character segment of the 16-character input-transfer sequence.

613-21. Since the binary coded 4 is still present on the Control Bus, the character-serial transfer of data between the controller and the Memory Interface continues, as previously described, until an entire block of 16 characters has been processed. As each character of input data is read by the System Interface it is also transferred through the MPU (via the MPU Data Bus) into the RAM.

613-22. After the controller presents the last input character

to the Digital Output PCB it removes the binary coded 4 from Control Bus A. With the control code gone the Interrupt input to the MPU goes low to inhibit additional data from being entered into the Input Register. This completes the initial phase (input data transfer) of the data transfer sequence.

613-23. The output transfer sequence begins as the MPU writes a binary coded 0 onto the Output Bus. A decoder detects the zero and issues an Enable input to the Recorder Status Logic. If the external device is ready to receive data, the Recorder Status Logic will provide a low Ready output which drives the MPU's test input high to indicate that an output transfer may commence. Since the Digital Output PCB is capable of transferring output data in a bit-serial-by-character format, as well as a bit-parallel-by-character format, each process will be considered separately.

613-24. Bit-parallel output data is stored, one character at a time, in a pair of 4-bit output registers. Data transfer to the registers is enabled by the PM input from the Memory Interface, and is entered on the leading edge of the OS pulse. As PM goes low the first output character, including 4-bits of supplementary data (ASCII, BDCIC, and/or EBCDIC), is placed onto address lines A0 through A7. After the character is entered by the subsequent OS pulse, the PM output is returned high. This PM transition arms the Write/Punch Logic to allow the rising edge of the next Sync pulse to initiate a Write/Punch output pulse. An appropriate amount of time later a second OS pulse is issued, and the write/punch output is terminated on the trailing edge of the next Sync pulse. As each bit-parallel character appears on the output lines (D0 through D7) a Parity Generator provides a ninth bit (jumper selectable odd or even) for parity.

613-25. The bit-serial output is enabled when the MPU instructs the RAM to place a binary coded 11 onto the Output Bus. Output data is then taken, a bit at a time, from the MPU's CY output and used to drive an EIA output buffer as well as relay K1. The mercury-wetted contacts of K1 are used to provide a current loop interface (contact closure for a 20 mA current loop).

613-26. The format of output data is established by the setting of 24 rocker switches which comprise a 3 X 8 switch matrix (see Figure 613-4). These switches are scanned at the beginning of each output transfer sequence by the MPU (via the RAM Output Bus) and read into the Memory Interface as six 4-bit characters. To read each character the MPU causes the RAM to sequentially lace binary coded numbers 1 through 5 onto the Output Bus. A 1-of- 10 decoder detects each number and effectively scans the matrix switches in groups of four. Thus, each closed switch with a scanned group causes a low level to be placed onto the normally high I/O Bus. (Isolation diodes are provided with each switch to avoid interaction between the various groups of matrix switches.) As each 4-bit word appears on the I/O Bus, it is read into the Memory Interface (by an IS pulse).

613-27. The transfer of output data, regardless of format, must be synchronized with the interfaced recorder. This is accomplished by the Recorder Status Logic which detects and reacts to a series of handshaking routines. For example, Ready and Punch input/outputs are used to synchronize the operation to a paper tape punch. Similarly, RS-232-C compatible recorders employ the Data-Set-Ready and Clear-to-Send inputs. Magnetic tape recorders utilize the Ready and Write lines to record data, and the EOR (end-of-record) and Gap-in-Progress lines to initiate (EOR) a standard inter-record gap, and to indicate its duration (Gap-in-Progress).

613-28. The Remote Start Logic, upon receipt of an external Start command, alters the Digital Output PCB's status response so as to initiate a data logger scan sequence (see Table 613-2). An acceptable start input is a >-5 ms contact closure to ground while the Scan-in-Progress output is high. When the controller interrogates the status of the Digital Output PCB (binary coded 6 on Control Bus A) the Remote Start Logic provides a start scan response via the Control Bus Decoder. During the following data transfer sequence the controller includes both a start-of-scan (binary coded 8) and an end-of-scan (binary coded 9) character with the normal data transfer characters. These two characters are decoded by the 1-of-10 decoder, and used to initiate and terminate the Scan-in-Progress (SIP) output. While the SIP output is active all start inputs are ignored.

613-29. MAINTENANCE

613-30. Access Information

613-31. Refer to the installation instructions given earlier in Digital Output PCB access information. Remove the rear panel output connector before attempting to remove the pcb from the data logger.

613-32. Performance Test

613-33. The Digital Output PCB Assembly is most easily tested under normal operating conditions. That is, installed in a functional data logger and interfaced with the recording device it normally drives. Output data format and characters can then be checked by comparing data recorded on the internal printer with hard copy data derived from the external recording device.

613-34. LIST OF REPLACEABLE PARTS

613-35. The lists of replaceable parts for the -14 series of data logger options are given in Tables 613-3, -4, and -5. Refer to Section 6 of the data logger manual for ordering information.

CAUTION

Indicated devices are subject to damage by static discharge.

TABLES 613-3, -4, and -5 LISTS OF REPLACEABLE PARTS NOT AVAILABLE

-14 series
Magnetic Tape Interface Options

614-1. SCOPE

614-2. The -14 Series Options include Options -14A through -14K, and are described in Table 614-1. Each option in the series is compatible with a Kennedy Magnetic Tape Recorder. The information contained herein deals with the basic Digital Output PCB used to interface these recorders.

614-3. INTRODUCTION

614-4. The Digital Output PCB is designed to transfer character-serial/bit-parallel data from the data logger to an external Kennedy Magnetic Tape Recorder. This includes, Time-of-Year, Fixed Data, Digital Input Data (Option -16), and measurement data. The appropriate carriage-return and line-feed characters are also generated. Provisions are included for initiating a scan sequence using a remote Start input.

614-5. A unique interface cable and a series of 24 switches on the pcb are used to tailor the digital output with the recorder. The cable is included as part of the option. The switches are set by the user to define characters per second and data format.

614-6. The Digital Output PCB transfers ASCII, BCDIC, and EBCDIC coded characters to the recorder, along with a write pulse. On some units odd or even parity can be selected by positioning a jumper wire on the pcb. On others, it is fixed at odd parity by the recorder. The pcb is shipped from the factory with the odd parity jumper installed.

614-7. After a preset number of characters (switch selectable) have been transferred to the recorder, the Digital Output PCB generates an End-Of-Record (EOR) command. The recorder responds by generating a standard EOR and returning a Gap-In-Progress signal to inhibit a data transfer during the IRG generation. If the scan mode is changed before the specified number of characters have been transferred, the Digital Output PCB will insert a $ character into the record until the character count is satisfied.

614-8. SPECIFICATIONS

614-9. Specifications for the -14 Series of options are given in Table 614-2.

614-10. INSTALLATION

614-11. Digital Output PCB

614-12. Up to three Digital Output PCB's can be mounted in the data logger's I/O slots, as shown in Figure 614-1. Install each

Table 614-1. Configuration of –14 Option

OPTION NO.	DESCRIPTION	TRACKS*	PARITY (ODD/EVEN)	OPTION COMPONENTS (INDICATED BY ●)		
				PCB	CABLE	RECORDER
–14A	Kennedy 1600/5 and Interface	7	Selectable	●	●	●
–14B	Kennedy 1610/5 and Interface	7	Selectable	●	●	●
–14C	Kennedy 1600/360 and Interface	9	Odd	●	●	●
–14D	Kennedy 1610/360 and Interface	9	Odd	●	●	●
–14E	Kennedy 1600/5 or 1610/5 Interface	7	Selectable	●	●	
–14G	Kennedy 1600/360 or 1610/360 Interface	9	Odd	●	●	
–14H	Kennedy 9832–7 and Interface	7	Selectable	●	●	●
–14I	Kennedy 9832–7 Interface	7	Selectable	●	●	
–14J	Kennedy 9832–9 and Interface	9	Odd	●	●	●
–14K	Kennedy 9832–9 Interface	9	Odd	●	●	

* 7 track = BCDIC or ASCII
9 track = EBCDIC or ASCII

Table 614-2. –14 Series Options Specifications

Compatibility	Specify at time-of-purchase using alphabetic suffix as shown in Table 614-1.
Output Format	Bit-parallel/character-serial
Output Levels	TTL compatible (–14A - –14G Positive-True: –14J & 14K Negative-True)
Output Code	BCDIC, EBCDIC or ASCII
Record Format	@CR, LF (Carriage Return, Line Feed) Time-of-Day (day, hr., min., s) CR, LF CR, LF, Fixed Data CR, LF Digital Inputs, CR, LF (–16 Option) Channels, limit, sign, data, function, CR, LF
Word Format	Unwanted word blocks may be deleted by switches on PCB. Word order cannot be changed.
Physical Record Length	Fixed. 1 to 4096 characters, switch selectable on PCB.

-14 Series pcb as follows:

WARNING

REMOVE LINE POWER AND ALL OTHER HIGH VOLTAGE INPUTS TO THE DATA LOGGER BEFORE STARTING THIS PROCEDURE.

1. Set the data logger's POWER switch to OFF.

2. Remove the top cover from the data logger.

3. Locate the Data Format switches on each -14 Series Digital Output PCB, as shown in Figure 614-1.

4. With reference to Figure 614-2, establish the format of recorded data as follows:

   a. Set switches 0 through 11 to OFF. This establishes the format shown in Figure 614-2.

   b. Delete any combination of unwanted character segments by setting the appropriate switches to ON.

   c. Set switches 12 through 23 to indicate (in binary) one less than the maximum number of characters to be recorded during a scan sequence. One (binary coded zero) to 4096 (binary coded 4095) characters can be selected (1 = ON).

5. Refer to Figure 614-3 and check to ensure that the parity jumper is properly positioned. If necessary, reposition the jumper to obtain the desired odd or even parity.

6. Align the Digit Output PCB in the selected I/O slot so that the large female connector is toward to rear of the data logger, and the small board-edge connector is toward the bottom of the unit. Push the pcb straight down onto the mating connector.

7. After the Digital Output PCB(s) is (are) installed, install the top cover.

614-13. Interface Cable

614-14. The interface cable supplied with the -14 Series Options is designed to connect the Digital Output PCB to the appropriate Kennedy Magnetic Tape Recorder. If the data logger scan sequences are to be manually initiated using the front-panel switches, connect the interface cable between the Digital Output PCB's

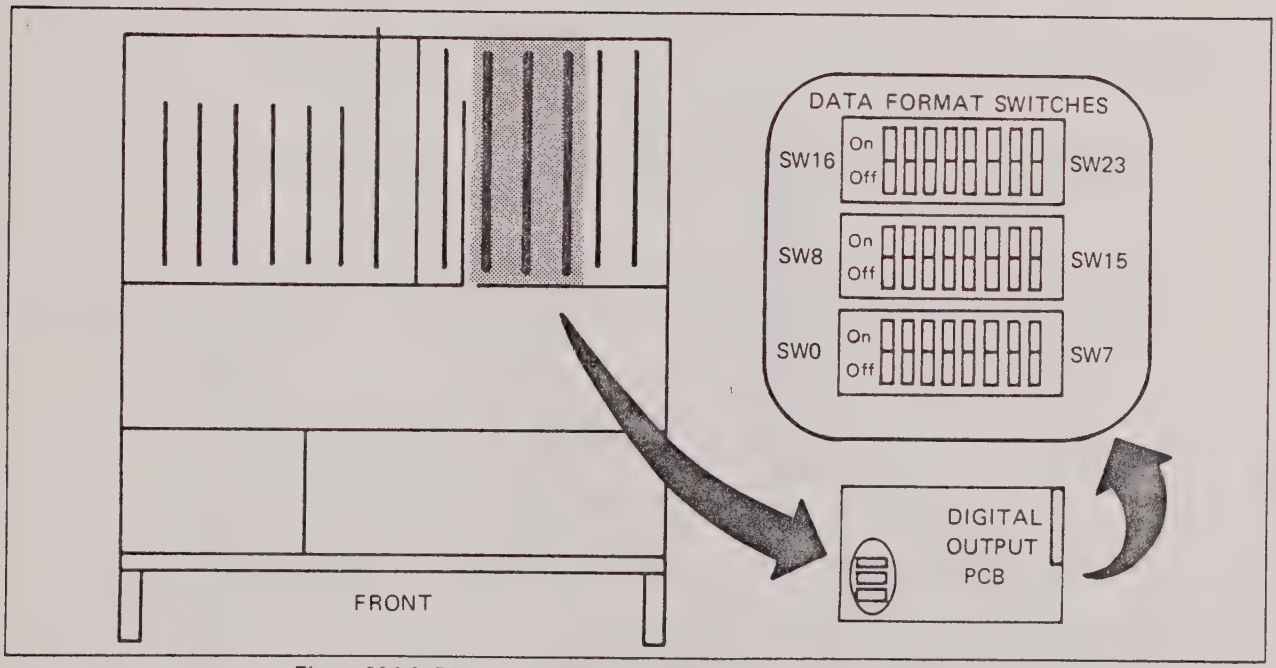


Figure 614-1. Digital Output PCB, Installation and Switch Locations

DETAILS OF RECORDED DATA

DESCRIPTION	RECORDED DATA FORMAT AND CONTROL SWITCH (0 thru 11) ASSIGNMENTS*
START OF SCAN	@ CR LF
TIME OF YEAR (2240C ONLY)	D D D : H H : M M : S S CR LF SW 0 … SW1
SCAN COUNTER (2200A) FIXED DATA (2240C)	CR LF SP SP FD FD FD FD FD FD CR LF SW2 … SW3
DIGITAL INPUT DATA (Option–16)	AC AC SP DD DD DD DD DD DD DD DD DD CR LF
MEASUREMENT DATA –NORMAL	CH CH CH SP > < ± AD AD AD · AD AD SP m SP V C F CR LF SW4 SW5 SW6 SW7 SW8 SW9 SW10 SW11 Floating Decimal Point MEASUREMENT UNITS
MEASUREMENT DATA –ABNORMAL	CH CH CH SP SP SP OVERLOAD O B L T SP SP SP m SP V C F CR LF BROKEN THERMOCOUPLE MEASUREMENT UNITS

CHARACTERS PER RECORD SWITCH SETTINGS (12 thru 23)

Set switches to indicate, in binary, one less than the maximum number of recorded characters per record. For example a binary coded 499 is equal to 500 recorded characters per record.

SETTINGS INDICATE CHARACTERS PER RECORD +1

SWITCHES	20	21	22	23	16	17	18	19	12	13	14	15
BINARY EQUIVALENT	2^{11}	2^{10}	2^{9}	2^{8}	2^{7}	2^{6}	2^{5}	2^{4}	2^{3}	2^{2}	2^{1}	2^{0}
DECIMAL EQIVALENT	2048	1024	512	256	128	64	32	16	8	4	2	1

*MNEMONICS

AC	=	Address Code
AD	=	Analog Data
CH	=	Channel Number
CR	=	Carriage Return
D	=	Day Code
DD	=	Digital Input Data
FD	=	Fixed Data
H	=	Hours
LF	=	Line Feed
M	=	Minutes
S	=	Seconds
SP	=	Space

Figure 614-2. Recorded Data Format and Digital Output PCB Switch Assignments

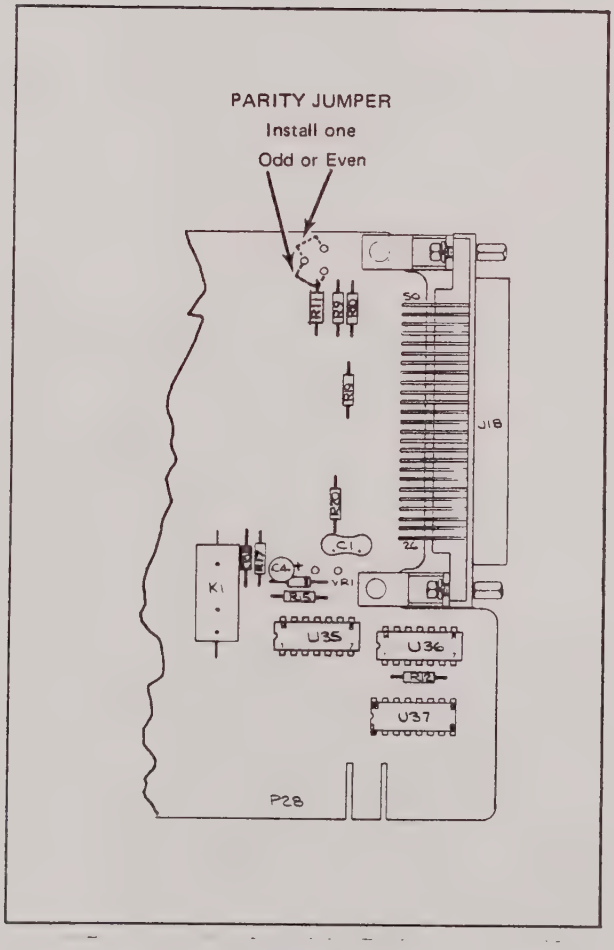


Figure 614-3. Parity Jumper Location, —14 Series Options

rear-panel connector and the tape recorder. If the scan sequence is to be initiated by a remote input, complete the following procedure prior to connecting the interface cable:

1. Remove approximately 2 inches of the sleeving covering the data logger end of the cable, behind the connector.

2. Seperate the three wires outside the main cable, under the sleeving.

3. Identify each wire, using an Ohmmeter.

   a. Pin 31 - Start

   b. Pin 6 - Scan In Progress

   c. Pin 48 - Logic Common

4. Install the interface cable and connect the remote control lines to the desired control source. The function of each line is described below:

   a. START - If the REMOTE switch in the data logger's SCAN CONTROL switch group is depressed, a contact closure to Logic Common or a low TTL/DTL logic level will initiate a scan sequence. If a scan is in progress, the Start input is ignored.

   b. SIP - A TTL output that goes low to indicate that a scan is in progress. Starts input during this period are ignored. SIP also goes low when REMOTE is pressed, and will remain low until and external START is received and the first scan sequence is completed.

   c. LOGIC COMMON - Logic common for the Start input and the SIP output signals.

NOTE

If a single remote control source is used and more than one Digital Output PCB is installed, it is sufficent to complete the remote control connections on only one interface cable.

614-15. OPERATION

614-16. Once installed in the data logger, the Digital Output PCB requires no operator attention. Instructions for connecting

the remote control lines are given earlier under installation. Refer to the appropriate Kennedy Instruction Manual for details concerning the magnetic tape recorder.

1. Apply a momentary contact closure to ground (48) or a low logic level to the Start input (31). If SIP (6) is initially low (prior to Start input), allow the first scan sequence to complete. SIP will return high at the end of the sequence and will go low for subsequent scan sequences.

2. While the Scan In Progress output is high (i.e., no keyboard or front panel activity) a negative-going Start pulse with a width of >-5 ms will cause a remote start.

3. Under worst case keyboard activity, a Start pulse >-100 ms is required to ensure a remote start.

4. If the Start input is held low from the start to finish of a scan sequence, a second scan will be initiated. A continuous scan mode is achieved by holding the Start input low.

614-18. THEORY OF OPERATION

614-19. The Digital Output PCB, as shown in Figure 614-4, is a microprocessor based subsystem which functions as a controller peripheral to provide the interface necessary to transfer data logger time-of-day, digital data, heading, and measurement data (as printed on the internal printer) to an external digital recording device. Any one of several types of recorders can be accommodated by the interface. Among these are: a 20 mA current-loop teleprinter (-11 Options), a paper tape punch (-13 Options), an incremental magnetic tape recorder (-14 Options), or any RS-232-C compatible recording device. Once the recorder is defined, the interface pcb can be tailored to meet the interface requirements by the addition of two plug-in ROMs and an interface cable (both are supplied as an integral part of the option). Additional formatting and baud rate requirements (when applicable) are manually selected using a series of 24 switches located on the pcb. (See installation instructions for switch settings as they apply to this option.) Provisions are also included which allow a contact closure to ground (or any other low-level input) to serve as a remote start-of-scan signal to the data logger. While a scan is in progress (SIP), an SIP output is generated to indicate that subsequent start inputs will not be accepted until the current scan sequence has been completed.

614-20. Data transfer from the controller to the external recorder is accomplished in two operations: first, an input transfer sequence, and then, an output transfer sequence. The input transfer sequence is executed under the direction of the controller and includes the character-serial transfer of 16

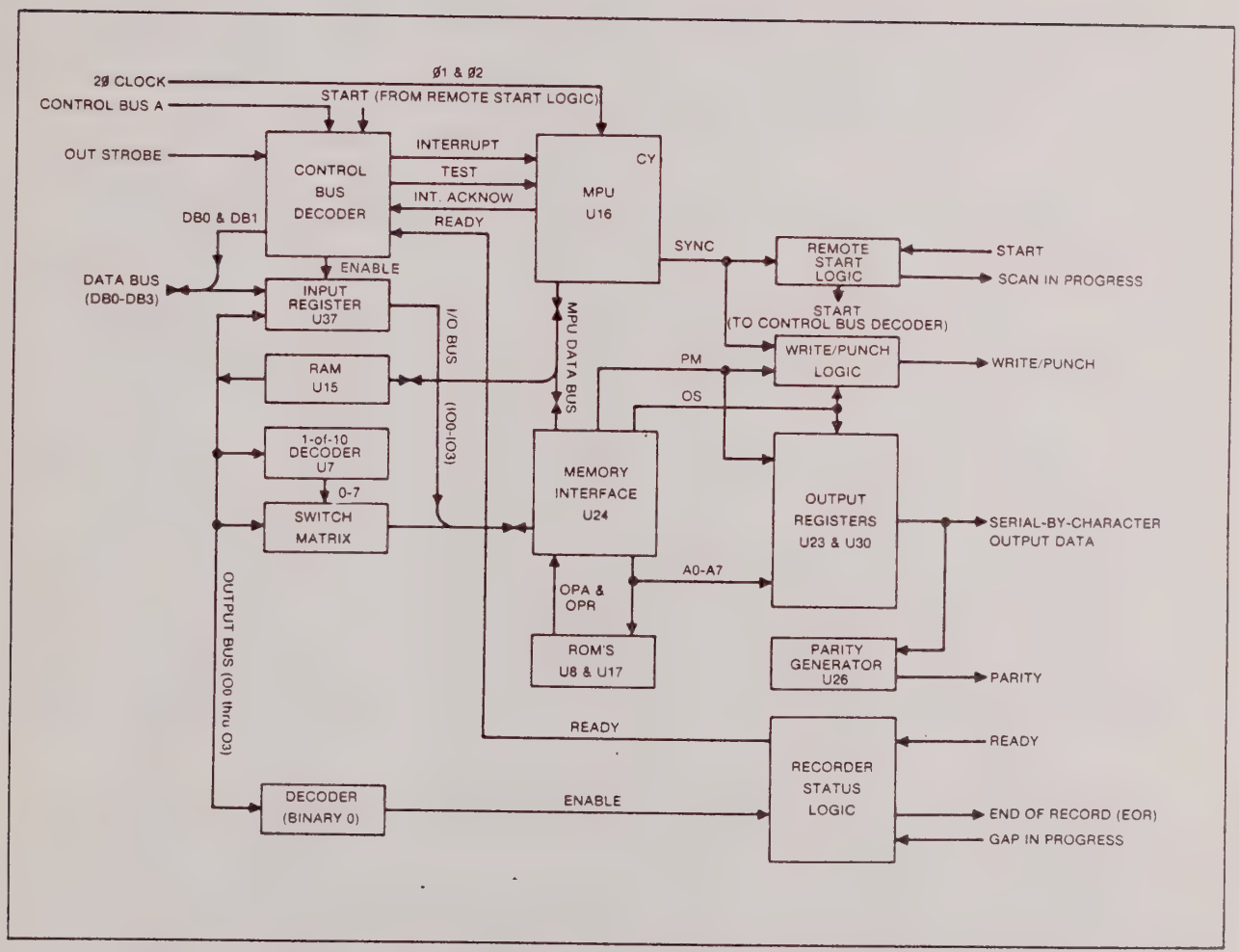


Figure 614-4. Digital Output PCB Simplified Block Diagram

four-bit characters from the controller (via the Data Bus) to a storage location (RAM) on the Digital Output PCB. After the input transfer is complete, the microprocessor on the Digital Output PCB directs the execution of the output transfer sequence. That is, the transfer of data from the storage location to the recording device. Appropriate handshaking is employed to ensure the output transfer is synchronized with the recorder.

614-21. When the controller is ready to initiate a data transfer it interrogates the status of the Digital Output PCB by placing a binary coded 6 onto Control Bus A. A decoder on the pcb detects the 6 and initiates an appropriate status response via the Data Bus. Table 614-3 lists the possible responses and their meanings.

614-22. Upon receiving a binary coded 3 (11) as a status response, the controller initiates the data transfer sequence by simultaneously placing a binary coded 4 onto Control Bus A, and the first data character (4-bits) onto the Data Bus. A Control Bus Decoder detects the control character (binary coded 4) and responds by generating an Interrupt to the MPU and an input Enable to the 4-bit Input Register. On the rising edge of the accompanying Out Strobe, the Test input to the MPU is driven high and the character on the Data Bus is entered into the Input Register. As a result of the high Interrupt and Test inputs, the MPU issues a low Interrupt Acknowledge. (Busy is used in the event the status of the Output PCB is interrogated prior to completing the entire data transfer to the peripheral device; see Table 614-3.) At the same time the MPU causes the output RAM to place a binary coded 8 onto the Output Bus. The presence of this code plus a subsequent IS pulse (generated by the Memory Interface) enables the contents of the Input Register to be read (via the I/O Bus) by the Memory Interface. On the trailing edge of the IS pulse, the MPU's test input is returned low to complete the first character segment of the 16-character input-transfer sequence.

614-23. Since the binary coded 4 is still present on the Control Bus, the character-serial transfer of data between the controller and the Memory Interface continues, as previously described, until an entire block of 16 characters has been processed. As each character of input data is read by the System Interface, it is also transferred through the MPU (via the MPU Data Bus) into the RAM.

614-24. After the controller presents the last input character to the Digital Output PCB it removes the binary coded 4 from the Control Bus A. With the Control code gone, the Interrupt input to the MPU goes low to inhibit additional data from being entered into the Input Register. This completes the initial phase (input data transfer) of the data transfer sequence.

614-25. The output transfer sequence begins as the MPU writes a binary coded 0 onto the Output Bus. A decoder detects the zero and issues an Enable input to the Recorder Status Logic. If the

Table 614-3. Description of Status Response Codes

Status Response		Meaning of Status Response
DB1	DB0	
0	0	Remote Start commanded but transfer in progress. Wait until not Busy.
0	1	Remote Start. Initiate a scan sequence.
1	0	Busy. Data transfer in progress. No action required.
1	1	Initiate a data transfer sequence.

external device is ready to receive data, the Recorder Status Logic will provide a low Ready output which drives the MPU's test input high to indicate that an output transfer may commence. Since the Digital Output PCB is capable of transferring output data in a bit-serial-by-character format, as well as, a bit-parallel-by-character format, each process will be considered separately.

614-26. Bit-parallel output data is stored, one character at a time, in a pair of 4-bit output registers. Data transfer to the registers is enabled by the PM input from the Memory Interface, and is entered on the leading edge of the OS pulse. As PM goes low the first output character, including four-bits of supplementary data (ASCII, BCDIC, and/or EBCDIC), is placed onto address lines A0 through A7. After the character is entered by the subsequent OS pulse, the PM output is returned high. This PM transition arms the Write/Punch Logic to allow the rising edge of the next Sync pulse to initiate a Write/Punch output pulse. An appropriate amount of time later, a second OS pulse is issued, and the write/punch output is terminated on the trailing edge of the next Sync pulse. As each bit-parallel character appears on the output lines (D0 through D7) a Parity Generator provides a ninth bit (jumper selectable odd or even) for parity.

614-27. The bit-serial output is enabled when the MPU instructs the RAM to place a binary coded 11 onto the Output Bus. Output data is then taken a bit at a time from the MPU's CY output and used to drive an EIA output buffer as well as relay K1. The mercury-wetted contacts of K1 are used to provide a current loop interface (contact closure for a 20 mA current loop).

614-28. The format of output data is established by the setting of 24 rocker switches which comprise a 3 x 8 switch matrix (see Figure 614-4). These switches are scanned at the beginning of each output transfer sequence by the MPU (via the RAM Output Bus) and read into the Memory Interface as six 4-bit characters. To read each character the MPU causes the RAM to sequentially place binary coded numbers 0 through 5 onto the Output Bus. (Isolation diodes are provided with each switch to avoid interaction between the various groups of matrix switches.) As each 4-bit word appears on the I/O Bus, it is read into the Memory Interface (by an IS pulse).

614-29. The transfer of output data, regardless of format, must be synchronized with the interfaced recorder. This is accomplished by the Recorder Status Logic which detects and reacts to a series of handshaking routines. For example, Ready and Punch input/outputs are used to synchronize the operation to a paper tape punch. Similarly, RS-232-C compatible recorders employ the Data-Set-Ready and Clear-To-Send inputs. Magnetic tape recorders utilize the Ready and Write lines to record data, and the EOR (End-Of-Record) and Gap-In-Progress lines to initiate (EOR) a standard inter-record gap, and to indicate its duration (Gap-In-Progress).

614-30. The Remote Start Logic, upon receipt of an external Start command, alters the Digital Output PCB's status response so as to initiate a data logger scan sequence (see Table 614-3). An acceptable start input is a >-5 ms contact closure to ground while the Scan-In-Progress output is high. When the controller interrogates the status of the Digital Output PCB (binary coded 6 on Control Bus A), the Remote Start Logic provides a start scan response via the Control Bus Decoder. During the following data transfer sequence, the controller includes both a start-of-scan (binary coded 8) and end-of-scan (binary coded 9) character with the normal data transfer characters. These two characters are decoded by the 1-of-10 decoder, and used to initiate and terminate the Scan-In-Progress (SIP) output. While the SIP output is active all Start inputs are ignored.

614-31. MAINTENANCE

614-32. Access Information

614-33. Refer to the installation instructions given earlier for Digit Output PCB access information. Remove the rear-panel output connector before attempting to remove the pcb from the data logger.

614-34. Performance Test

614-35. The Digital Output PCB Assembly is most easily tested under normal operating conditions. That is, installed in a functional data logger and interfaced with the recording device it normally drives. Output data format and characters can then be checked by comparing data recorded on the internal printer with hard copy data derived from the external recording device.

614-36. LIST OF REPLACEABLE PARTS

614-37. The lists of replaceable parts for the -14 Series of data logger options are given in Tables 614-4, -5, and -6. Refer to Section 5 of the data logger manual for ordering information.

CAUTION

Indicated devices are subject
to damage by static discharge.

TABLES 614-4, -5, and -6 LISTS OF REPLACEABLE PARTS NOT AVAILABLE

Option -15
IEEE Interface

615-1. INTRODUCTION

615-2. The IEEE Interface (Option 2240B-15) is a plug-in pcb designed to provide the interface necessary to transfer programs and output data to and from devices on the IEEE-488 Bus (IEEE Standard 488, Digital Interface for Programmable instrumentation, hereafter referred to as IEEE-488) and a Model 2240C, 2241B, 2242B Data Logger. The option, along with an IEEE-488 Bus Interface Cable (not provided with this option), provides the required interface between the 2242B Data Logger and IEEE-488 Bus controller, such as the Fluke Model 1720A. The card is field installable using procedures given later under Installation.

615-3. Operation of the IEEE Interface can be functionally divided into two sequences: Talk and Listen. The Listen function transfers program information from the IEEE-488 Bus to the A3 controller pcb assembly in the data logger, and the Talk function transfers output data (scan and measurement data) from the data logger to the IEEE-488 Bus.

615-4. The IEEE Interface PCB consists of a single plug-in pcb card which can be installed in any one of the three data logger I/O slots. Access to the IEEE-488 Bus is accomplished by a back panel cable and connector. Once the pcb is installed, the Data Logger IEEE-488 Bus address and mode of operation can be set without removing the card from the data logger.

NOTE

2240B-15 and the 2240B-17 Options (Remote Programming Interface) cannot be installed in the data logger at the same time.

615-5. SHIPPING INFORMATION

615-6. Upon receipt of the IEEE Interface PCB, check carefully for shipping damage. If the pcb is damaged, contact the shipping carrier representive for inspection and request an inspection report. Before returning the pcb to the factory contact the local Fluke Customer Service Center.

615-7. If reshipment is necessary and the orignal container is not available, a new one can be obtained by writing the John Fluke Mfg. Co., Inc. Please reference the instrument model number, part, and part number when requesting a new shipping container.

615-8. INSTALLATION

615-9. The IEEE Interface PCB can be installed in any one of the data logger I/O slots shown in Figure 615-1. To install the pcb in a data logger, use the following procedure:

WARNING

REMOVE LINE POWER AND ALL OTHER HIGH VOLTAGE INPUTS TO THE DATA LOGGER BEFORE STARTING THIS PROCEDURE.

1. Set the data logger POWER switch to OFF.

2. Remove the top cover from the data logger.

3. Locate switch S2 on the pcb as shown in Figure 615-1. S2 is used to assign the IEE-488 Bus address code to the pcb.

4. With reference to Table 615-1, set positions 1 through 5 of S2 to assign the desired address character.

5. Locate switch S1 on the pcb as shown on Figure 615-1.

6. Refer to Table 615-2, and set positions 1 through 4 of S1 to define the configuration of the pcb.

7. Align the IEEE Interface PCB in the selected I/O slot, so that the female connector is toward the rear of the data logger, and the small board-edge connector is toward the bottom of the unit. Push the pcb straight down and into the mating connector.

8. After the pcb is installed, install the top cover.

615-10. IEEE-488 BUS INTERFACE CABLE

615-11. The IEEE Interface PCB is connected to devices on the IEEE-488 Bus by means of the IEEE-488 Bus Interface cable. The cable conforms to IEEE-488 Bus standards and can be ordered in three different lengths: 1 meter (Y8001), 2 meters (Y8002), and 4 meters (Y8003).

615-12. OPERATING NOTES

615-13. The following paragraphs describe various conditions that should be considered before attempting to operate the IEEE Interface PCB.

615-14. IEEE-488 BUS

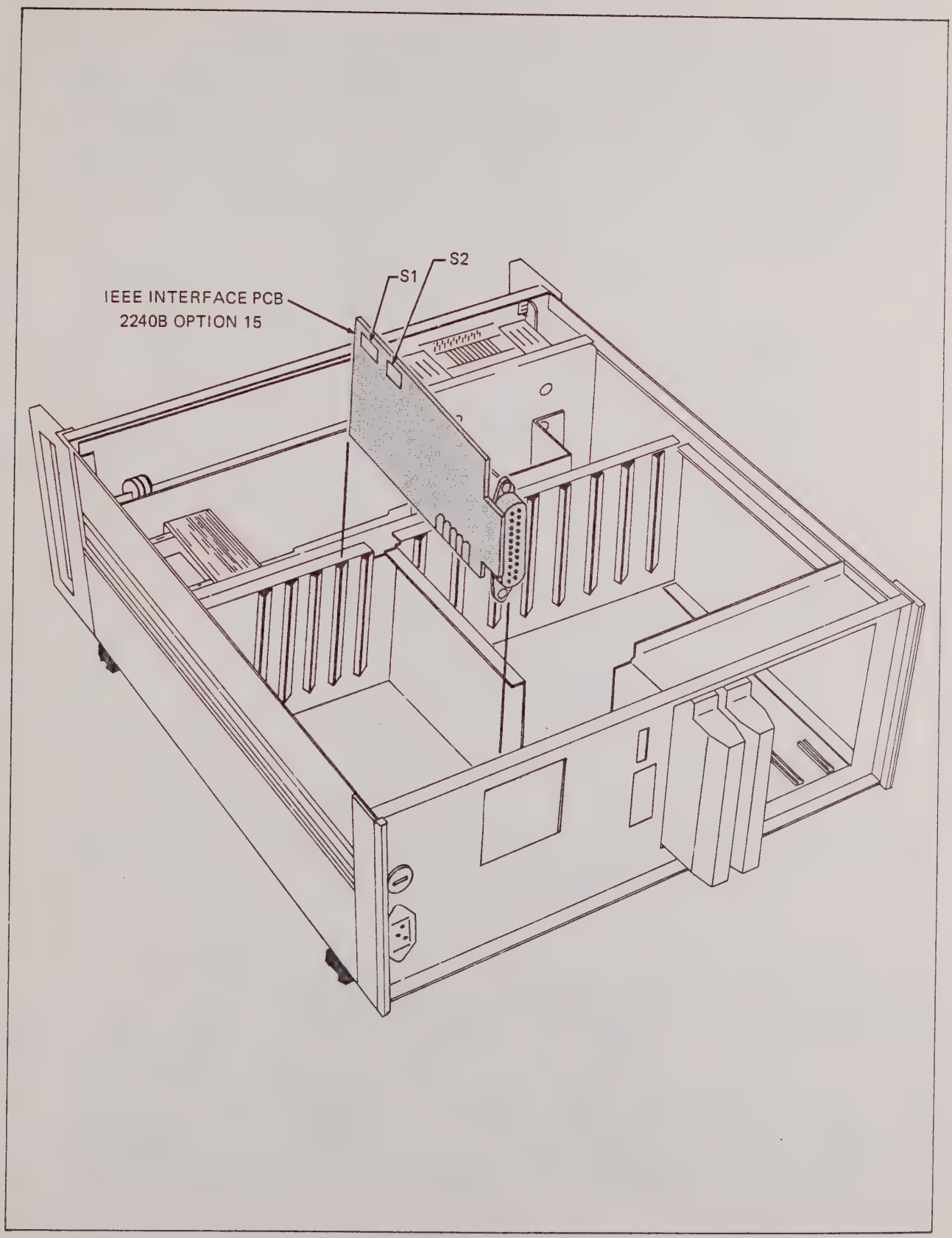


Figure 615-1. Installation and Switch Locations

Table 615-1. Switch S2, IEEE-488 Bus Address Selection

Talk Address = 1 0 X X X X X S2 Switch Setting = X X X X X
Listen Address = 0 1 X X X X X Switch ON = 1
OFF = 0

ADDRESS CODES		ADDRESS CHARACTERS		ADDRESS SWITCH SETTINGS				
DECIMAL	OCTAL	LISTEN	TALK	(5)	(4)	(3)	(2)	(1)
0	0	SP	@	0	0	0	0	0
1	1	!	A	0	0	0	0	1
2	2	"	B	0	0	0	1	0
3	3	#	C	0	0	0	1	1
4	4	$	D	0	0	1	0	0
5	5	%	E	0	0	1	0	1
6	6	&	F	0	0	1	1	0
7	7	'	G	0	0	1	1	1
8	10	(	H	0	1	0	0	0
9	11	)	I	0	1	0	0	1
10	12	*	J	0	1	0	1	0
11	13	+	K	0	1	0	1	1
12	14	,	L	0	1	1	0	0
13	15	–	M	0	1	1	0	1
14	16	.	N	0	1	1	1	0
15	17	/	O	0	1	1	1	1
16	20	0	P	1	0	0	0	0
17	21	1	Q	1	0	0	0	1
18	22	2	R	1	0	0	1	0
19	23	3	S	1	0	0	1	1
20	24	4	T	1	0	1	0	0
21	25	5	U	1	0	1	0	1
22	26	6	V	1	0	1	1	0
23	27	7	W	1	0	1	1	1
24	30	8	X	1	1	0	0	0
25	31	9	Y	1	1	0	0	1
26	32	:	Z	1	1	0	1	0
27	33	;	[	1	1	0	1	1
28	34	<	\	1	1	1	0	0
29	35	=	]	1	1	1	0	1
30	36	>	^	1	1	1	1	0

Table 615-2. Switch S1, Configuration/Interface Selection

SWITCH SLIDE	FUNCTION	ON	OFF
1	Talker Only Mode (ton)	Talker Only	Not enabled
2	Analog readings per line	4 RPL	1 RPL
3	SRQ Enable	Enabled	Not enabled
4	Not implemented	----------	----------
5	Not connected	----------	----------

615-15. IEEE-488 Bus is an interfacing arrangement suited for programmable measurement instrumentation systems. Sixteen bus transmission lines provide for all data and message transfer and control. Bus lines are defined under the following three categories:

1. Eight data bus lines (DI01-DI08) data or address information will be carried on these lines in bit-parallel, byte-serial format. Information transfer on these lines is asynchronous and bidirectional.

2. Three handshake lines:

   a. DAV (Data Valid): Indicates to a receiver that data is available on the DIO lines.

   b. NRFD (Not Ready For Data): Indicates whether all devices are ready to accept data.

   c. NDAC (Not Data Accepted): Indicates the acceptance of data by all devices.

3. Five bus management lines:

   a. ATN (Attention): When true (low), DI01-DI08 will carry addresses or commands; when false DI01-DI08 carry data.

   b. IFC (Interface Clear): When true, (low) enables the following states:

      Talker idle
      Serial Poll idle
      Listener idle

   c. SRQ (Service Request): operates as described by SRQ switch operation (Configuration/Interface Switch (S1) Operation: SRQ, (S1-3).

   d. REN (Remote Enable): Not used in the 2240C-15.

   e. EOI (End or Identify): Set true (low) when the last byte of data is present on the IEEE-488 Bus. The 2240C-15 sets EOI true on each LF (Line Feed).

615-16. A maximum of 15 devices may be interconnected on one contiguous bus structure. These devices may perform any combination of the following functions: talk, listen, or control. Figure 615-2 illustrates typical connections on the IEEE-488 Bus. Table 615-3 defines remote message coding used on the bus.

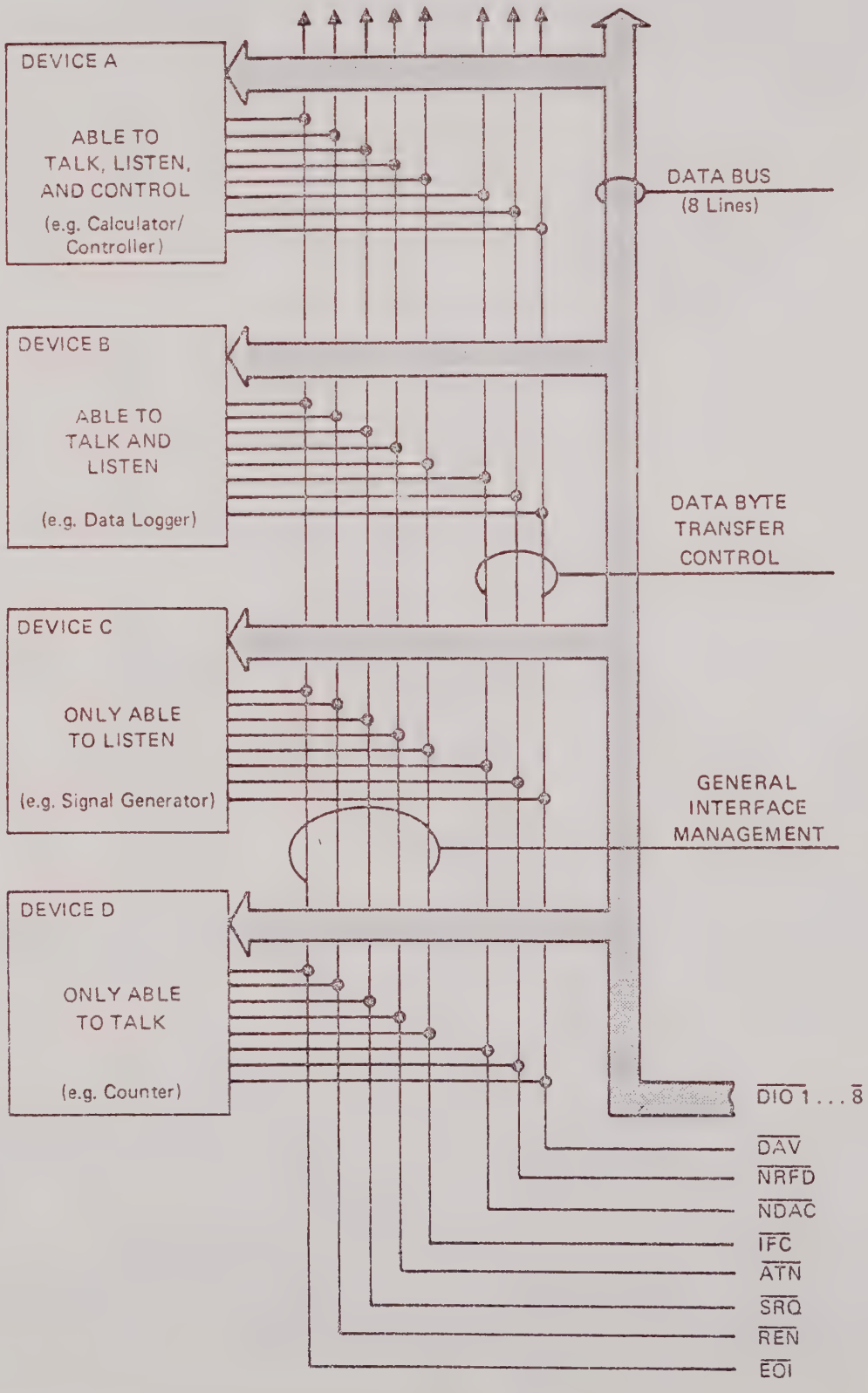


Figure 615-2. IEEE-488 Bus Connections

Table 615-3. Remote Message Coding

MNEMONIC	MESSAGE NAME	BUS SIGNAL LINE(S) AND CODING THAT ASSERT MESSAGE TRUE													MESSAGE TYPE	MESSAGE CLASS	NOTES
		DATA I/O								BUS MANAGEMENT							
		DI08	DI07	DI06	DI05	DI04	DI03	DI02	DI01	ATN	EOI	SRQ	IFC	REN			
ACG	Addressed Command Group	X	0	0	0	X	X	X	X	1	X	X	X	X	M	AC	
ATN	Attention	X	X	X	X	X	X	X	X	1	X	X	X	X	U	UC	
DAB	Data Byte	D8	D7	D6	D5	D4	D3	D2	D1	0	X	X	X	X	M	DD	1,6,7
DCL	Device Clear	X	0	0	1	0	1	0	0	1	X	X	X	X	M	UC	
END	End	X	X	X	X	X	X	X	X	0	1	X	X	X	U	ST	7
EOS	End of String	E8	E7	E6	E5	E4	E3	E2	E1	0	X	X	X	X	M	DD	2,7
GET	Group Execute Trigger	X	0	0	0	1	0	0	0	1	X	X	X	X	M	AC	
GTL	Go To Local	X	0	0	0	0	0	0	1	1	X	X	X	X	M	AC	
IDY	Identify	X	X	X	X	X	X	X	X	1	1	X	X	X	U	UC	
IFC	Interface Clear	X	X	X	X	X	X	X	X	X	X	X	1	X	U	UC	
LAG	Listen Address Group	X	0	1	X	X	X	X	X	1	X	X	X	X	M	AD	
LLO	Local Lock Out	X	0	0	1	0	0	0	1	1	X	X	X	X	M	UC	
MLA	My Listen Address	X	0	1	L5	L4	L3	L2	L1	1	X	X	X	X	M	AD	3
MTA	My Talk Address	X	1	0	T5	T4	T3	T2	T1	1	X	X	X	X	M	AD	4
MSA	My Secondary Address	X	1	1	S5	S4	S3	S2	S1	1	X	X	X	X	M	SE	5
NUL	Null Byte	0	0	0	0	0	0	0	0	0	X	X	X	X	M	DD	7
OSA	Other Secondary Address	(OSA = SCG • MSA)													M	SE	
OTA	Other Talk Address	(OTA - TAG • MTA)													M	AD	
PCG	Primary Command Group	(PCG = ACG + UCG + LAG + TAG)													M	—	
REN	Remote Enable	X	X	X	X	X	X	X	X	X	X	X	X	1	U	UC	
RQS	Request Service	X	1	X	X	X	X	X	X	0	X	X	X	X	U	ST	7
SCG	Secondary Command Group	X	1	1	X	X	X	X	X	1	X	X	X	X	M	SE	
SDC	Selected Device Clear	X	0	0	0	0	1	0	0	1	X	X	X	X	M	AC	
SPD	Serial Poll Disable	X	0	0	1	1	0	0	1	1	X	X	X	X	M	UC	
SPE	Serial Poll Enable	X	0	0	1	1	0	0	0	1	X	X	X	X	M	UC	
SRQ	Service Request	X	X	X	X	X	X	X	X	X	X	1	X	X	U	ST	
STB	Status Byte	S8	X	S6	S5	S4	S3	S2	S1	0	X	X	X	X	M	ST	6,7
TCT	Take Control	X	0	0	0	1	0	0	1	1	X	X	X	X	M	AC	
TAG	Talk Address Group	X	1	0	X	X	X	X	X	1	X	X	X	X	M	AD	
UCG	Universal Command Group	X	0	0	1	X	X	X	X	1	X	X	X	X	M	UC	
UNL	Unlisten	X	0	1	1	1	1	1	1	1	X	X	X	X	M	AD	
UNT	Untalk	X	1	0	1	1	1	1	1	1	X	X	X	X	M	AD	

SYMBOLS

Type
- U = Uniline Message
- M = Multiline Message

Class
- AC = Address Command
- AD = Address (Talk or Listen)
- DD = Device Dependent
- HS = Handshake
- UC = Universal Command
- SE = Secondary
- ST = Status

0 = Logical Zero (HIGH Signal Level)

1 = Logical One (LOW Signal Level)

X = Don't Care or Not Driven

NOTES

(1) D1-D8 specify the device dependent data bits

(2) E1-E8 specify the device dependent code used to indicate EOS message

(3) L1-L5 specify the device dependent bits of the device's listen address

(4) T1-T5 specify the device dependent bits of the device's talk address

(5) S1-S5 specify the device dependent bits of the device's secondary address

(6) S1-S6, S8 specify the device dependent status. (DI07 is used for the RQS message)

(7) The true message value must be ignored when received the LACS is inactive

615-17. PROGRAMMING FORMAT

615-18. The IEEE Interface PCB is capable of accepting a series or string of alpha-numeric characters and interpreting them as control/program data. These data command strings when properly formatted, enable the IEEE-488 bus controller to program the following data logger functions:

1. Scan Control
2. Output Control
3. Time
4. Scan Format
5. Channel Programming
6. Limits Programming

615-19. The format of the command string is shown in Table 615-4. It consists of a command character, a numeric data field, and a carriage return terminator. An alphabetic command character defines the function to be programmed (scan control, output control, etc). The commanded function is then programmed by a series of numeric characters. These characters represent a variable length numeric field and may contain a number of delimiters in the form of commas (,). After the numeric field is complete, the command string is both terminated and executed by a carriage return (CR) character.

NOTE

A delimiter cannot be used for concatenation of command strings. Each string must be individually terminated.

615-20. A complete list of command characters and their associated numeric fields are given in Table 615-5. Proper formatting of a typical programming sequence is shown in Table 615-6.

615-21. Output Format

615-22. Output format from the IEEE Interface PCB is recorded at the IEEE-488 talker device in the standard format shown in Table 615-7. A switch (S1-2) on the IEEE Interface PCB allows selection of either one or four measurement data readings per line.

615-22. Configuration/Interface Switch (S1) Operation

615-23. SRQ (Service Request)

TABLES 615-4 and 615-5 NOT AVAILABLE

615-24. When SRQ is enabled (switch S1-3 = on) the IEEE Interface PCB requests service from the IEEE-488 Bus controller when it contains a complete "data logger" reading. Service is requested by asserting the SRQ bus management line low. The SRQ line is released by the IEEE Interface PCB when the first data byte is transferred onto the IEEE-488 Bus from the output buffer. The IEEE Interface responds to a serial poll interrogation by a controller on the IEEE-488 Bus. The serial poll response can be a 41 hex code (ASCII "A") if the IEEE Interface has initiated the service request, or a D hex code (ASCII "null") if it had not. If the IEEE Interface has initiated an SRQ and the current reading has not been entirely read (through the terminating CR/LF) characters) all data logger scanning stops. Scanning resumes when the complete current reading has been completely read.

615-25. When SRQ is not enabled (S1-3 = OFF), the IEEE Interface PCB continuously updates its output with the current reading until addressed as a talker. When addressed as a talker, the current reading is held. The data logger stops scanning until the full reading has been taken or an untalk signal has been sent to the IEEE Interface PCB.

615-27. TON (Talker Only)

615-28. When TON is enabled, (Switch S1-1 = on) the IEEE Interface PCB automatically enters the Talker Addressed State (TADS). To use this function, three switches must be set. The LOCAL/REMOTE switch (S1) located on the A3 Controller must be set to LOCAL, and the SCAN control and OUTPUT control must be selected on the 2240C front panel (see Section 2 of the 2240C Instruction Manual).

615-29. Analog Readings Per Line

615-30. When switch S1-2 is enabled (ON), a CR/LF character is opened to every fourth analog reading output to the IEEE-488 Bus. The 1st, 2nd, and 3rd analog readings are followed by two spaces.

615-31. OPERATION

615-32. Once installed, the IEEE Interface PCB requires no operator attention other than ensuring that normal turn-on procedures are observed for both the data logger and devices on the IEEE-488 Bus. Select the remote mode of operation either manually or remotely as required by the position of switch S1 on the data logger A3 Controller PCB (see Section 2, Figure 2-6 of the 2240C Instruction Manual). Follow the programming format given earlier to control the operation of the data logger. Each of the remote programming functions correspond to the manual functions described in Section 2 of the 2240C Instruction Manual.

615-33. THEORY OF OPERATION

615-34. The IEEE Interface PCB, as shown in Figure 615-3 is a

FIGURE 615-3 NOT AVAILABLE

microprocessor based subsystem which functions as an A3 Controller peripheral to provide the interface necessary to transfer data logger program and output data to and from devices on the IEEE-488 Bus. Once devices on the IEEE-488 Bus have been defined, the IEEE Interface PCB is tailored to meet the interface requirements by setting a series of switches on the pcb. (See installation instructions for switch settings as they apply to this option). These settings are read by the MPU (Microprocessor Unit) and stored in the memory PROMS (Programmable Read Only Memories) U21 and U11 via the memory interface (U6) each time the data logger is turned on.

615-35. Operation of the IEEE Interface PCB can be functionally divided into two sequences: Listen and Talk. The Listen function involves the transfer of program information from the IEEE-488 Bus to the A3 Controller in the data logger. The Talk function involves the transfer of output data (scan and measurement data) from the data logger to the IEEE-488 Bus. For both cases, each I/O word up to 16 characters) is temporarily stored on the IEEE-488 Interface PCB to synchronize its transfer operations with either the A3 Controller PCB or devices on the IEEE-488 Bus as required.

615-36. Listen Function

615-37. Bit-parallel, byte-serial program data from the IEEE-488 Bus is received by the PCB through IEEE-488 compatible transceivers to the GPIA (General Purpose Interface Adapter) U3. When a character byte is received, the GPIA generates an Interrupt Request (IRQ) low (0.0v) output, (IRQ is connected to the INT input on the MPU.) In response to an Interrupt (INT) low input, the MPU reads the 8-bit GPIA data in character byte via GPI/O U2 and the MPU Data Bus. Data characters received by the MPU, are transferred to, and stored in RAM 0 (Random Access Memory). When a complete command (up to 16 characters) has been assembled, the MPU checks it for errors and formats it for use by the data logger's A3 Controller PCB. Then RAM 0 initiates IRQ to notify the A3 Controller PCB that data is ready to be processed.

615-38. In response to the IRQ, the A3 Controller PCB begins to poll the various I/O pcB's to determine which pcb requested the interrupt, and what service, if any, is required. To poll the IEEE Interface PCB, the A3 Controller places a binary coded 6 onto Control Bus A (CA0-CA3). The pcb detects its code and responds with its current status via the System Data Bus. The possible response codes and their meanings are shown in Table 615-8. When the IEEE Interface PCB has initiated an interrupt request (IRQ), it confirms the action by placing a binary coded 7 on the System Data bus as a response code.

615-39. When the A3 Controller PCB is ready to receive data from the IEEE Interface PCB, it places a binary coded 14 onto Control Bus A. The code is detected by the Control Bus Decoders which in turn, enables data from port Y of the GPI/O (U23) to be placed

TABLES 615-6, -7, and -8 NOT AVAILABLE

onto the System Data Bus. The decoded transmit code (Binary 14) is latched onto port W of the GPI/O with every Sync pulse. Concurrently, the MPU, on every Sync pulse, reads port D of the GPI/O (U23). When it detects a data request code (Binary 14), it proceeds to transfer 16 characters to the A3 controller via port Y of the GPI/O. At the end of the transfer, the Controller terminates the sequence by removing the binary coded 14 from the Control Bus.

615-40. Talk Function

615-41. When the A3 Controller PCB is ready to put data onto the IEEE-488 Bus, it polls the status of the IEEE Interface PCB by placing a binary coded 6 on Control Bus A. If the PCB is not busy it responds with a binary 15 via the System Data Bus and thereby prompts the controller to output data onto the IEEE-488 Bus. The controller places a binary coded 4 onto Control Bus A. This code is latched into port W of the GPI/O (U23) for later reference by the MPU. Subsequent data characters that appear on the System Data Bus are serially loaded into the FIFO (First-In First-Out) and held until accessed by the MPU. When accessed by the MPU, the 16 data characters are serially loaded into port X of the GPI/O (U23) by pulse Z1. All 16 characters are transferred and stored in RAM 0 for further processing. Processed data is transferred to RAM 1 and 3 to await output to the IEEE-488 Bus. During the remainder of the sequence, the MPU checks the content and format of the received data. Before transfer to the IEEE-488 Bus occurs, the MPU polls the status of the GPIA and IEEE-488 Bus Control lines. If the IEEE Interface PCB is addressed as a talker, NRFD (Not Ready For Data) is false (high) and the data out register of the GPIA is empty. The MPU also checks to see if SRQ is to be sent out. Data is then sent to the data out register of the GPIA for output on the IEEE-488 Bus.

615-42. Each character is transformed into an ASCII seven-level character by the MPU before being presented to the GPIA via ports W and X of the GPI/O (U23). Port Y is used to address the appropriate register in the GPIA. Each character is entered into the GPIA data out register by strobe Z0. The data is then sent to listeners on the IEEE-488 Bus via the handshake process.

615-43. MAINTENANCE

615-44. Access Information

615-45. Refer to the installation instructions given earlier in this subsection for IEEE Interface PCB access information. Remove the rear panel output connector before attempting to remove the pcb from the data logger.

615-46. Performance Test

615-47. The IEEE Interface PCB is most easily tested under normal operating conditions; i.e., installed in a functional data

logger and interfaced with a IEEE-488 Bus Controller. Output data can then be checked by comparing data recorded on the internal printer with hard copy data derived from the external recording device. Similarly, the effects of remote programming can be compared with manual programming to isolate malfunctions to the pcb level.

615-48. If a malfunction has been isolated to the IEEE Interface PCB, replace it and send the malfunctioning pcb back to the manufacturer (see Shipping Information).

615-49. LIST OF REPLACEABLE PARTS

615-50. The lists of replaceable parts for the -15 Option are given in Table 615-9. Refer to Section 5 of the data logger manual for ordering information.

TABLE 615-9 LIST OF REPLACEABLE PARTS NOT AVAILABLE

Option -16
Digital Input Option

616-1. INTRODUCTION

616-2. The Digital Input Option (-16) is a plug-in pcb assembly designed to provide the printer and external recording devices with up to nine digits of externally generated digital input data. The data is derived from a remote source in bcd character-parallel format (DTL/TTl, positive-true) and loaded into storage by a remote Load Data pulse. Data cannot be loaded while the recorders are reading input data, and Bus Busy output flags are provided to indicate the read period. Read period occurs immediately prior to the first analog data reading.

616-3. The data logger is capable of accommodating up to three Digital Input PCBs. Digital data from the pcbs is read in a sequence determined by the setting of four Address Code Switches located on each pcb. These address codes are assigned by the user so that if the first pcb to be read is coded as address 0, the second is coded 1, and the third is coded 2. The physical order in which the pcbs are installed in the data logger does not influence the order in which data is read.

616-4. SPECIFICATIONS

616-5. Specifications for the Digital Input Option (-16) are given in Table 616-1.

616-6. INSTALLATION

616-7. Up to three Digital Input PCBs can be mounted in the data logger's I/O slots, as shown in Figure 616-1. Install each pcb as follows:

WARNING

REMOVE LINE POWER AND ALL OTHER HIGH VOLTAGE INPUTS TO THE DATA LOGGER BEFORE STARTING THIS PROCEDURE.

1. Set the data logger's POWER switch to OFF.

2. Remove the top cover from the data logger.

3. Locate the Address Code Switches on each Data Input PCB as shown in Figure 616-1, and assign consecutive address codes (starting with 0) to each pcb by setting the switches to the patterns shown in Table 616-2. When Digital Input Data is recorded, address 0 is read first, 1 second, and 2 last.

Table 616-1. Digital Input Option Specifications

Number of Digits	Nine
Input Code	BCD, positive-true
Logic Levels	DTL/TTL
Control Inputs	Load Data, Busy, $\overline{\text{Busy}}$
Record Location	Follows Fixed Data

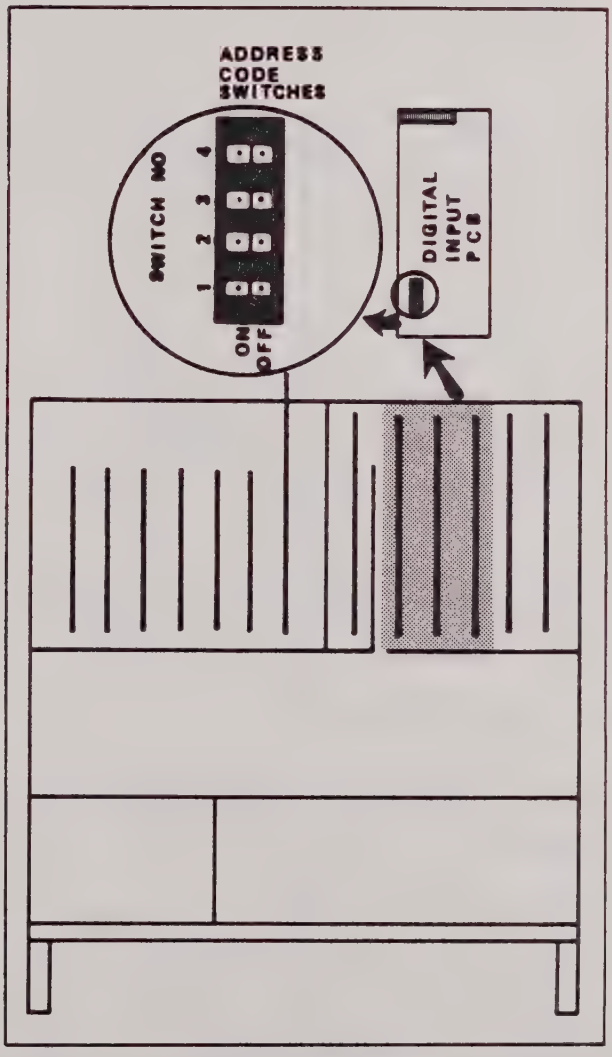


Figure 616-1. Data Input Option, Installation and Switch Locations

Table 616-2. Address Code Switch Settings

ADDRESS CODE	ADDRESS CODE SWITCH SETTINGS			
	1	2	3	4
0	ON	ON	ON	ON
1	ON	ON	ON	OFF
2	ON	ON	OFF	ON

4. Align each Data Input PCB in its selected I/O slot so that the large female connector is toward the rear of the data logger, and the small board-edge connector is toward the bottom of the unit. Push the pcb straight down onto the mating connector.

5. After the Digital Input PCB(s) is (are) installed, install the top cover.

616-8. OPERATION

616-9. Once installed in the data logger, the Digital Input Option requires no operator attention. However, certain considerations are necessary to properly interface the option with remote input data. These considerations are covered in the following paragraphs.

616-10. Interface Connections

616-11. Remote interface connections to a Digital Input PCB are completed through a General Purpose Interface Cable (2200A-7006) or a blank Interface Connector (2200A-7007) which attaches to the rear of the data logger. The cable assembly and the connector are available as accessories. Descriptions of both are given earlier in this section under accessories.

616-12. The user is responsible for completing the cable connections to the remote data source. The pin assignments for the Digital Input Option rear-panel connector are given in Table 616-3.

616-13. I/O Data Requirements

616-14. The I/O requirements necessary to load data into a Digital Input Option PCB are given in Table 616-4. See Table 616-3 for I/O connector pin assignments.

616-15. Ground Loop Considerations

616-16. Data inputs to the Digital Input PCB are not isolated and therefore, are referenced to the data loggers unguarded +5V dc supply (logic common). To protect both the data logger and the external data source from damage due to ground loops, a fuse is installed on the Digital Input PCB. Fuse replacement details are given later under maintenance.

616-17. THEORY OF OPERATION

616-18. The Digital Input PCB, as shown in Figure 616-2, functions as a remote data interface to provide the controller with up to nine externally-generated digits of input data. Ultimately, the controller presents this data to the printer as supplemental heading information. The input digits are derived from a user supplied data source and are received at the Digital

Table 616-3. Option —16, I/O Connector (J33) Pin Assignments

PIN	SIGNAL		PIN	SIGNAL	
1	N/C		26	$\overline{\text{LOAD}}$	
2	DB0	DIGIT 4	27	DB3	DIGIT9 (MSD)
3	DB1		28	DB2	
4	DB2		29	DB1	
5	DB3		30	DB0	
6	$\overline{\text{BUSY}}$		31	SIGNAL GND.	
7	BUSY		32	SIGNAL GND.	
8	DB3	DIGIT 3	33	DB0	DIGIT8
9	DB2		34	DB1	
10	DB1		35	DB2	
11	DB0		36	DB3	
12	N/C		37	+5V dc	OUT-PUT
13	N/C		38	+5V dc	
14	DB3	DIGIT 2	39	DB0	DIGIT7
15	DB2		40	DB1	
16	DB1		41	DB2	
17	DB0		42	DB3	
18	N/C		43	DB0	DIGIT6
19	N/C		44	DB1	
20	DB3	DIGIT 1 (LSD)	45	DB2	
21	DB2		46	DB3	
22	DB1		47	DB3	DIGIT5
23	DB0		48	DB2	
24	N/C		49	DB1	
25	N/C		50	DB0	

N/C = No Connection

Table 616-4. I/O Data Requirements

Logic Levels	DTL/TTL compatible, positive true.
Input Data Format.	Up to nine BCD, character-parallel digits.
Load Pulse	Input Data is loaded by a negative going pulse at the Load input. The pulse duration must be $\geq$50 μs.
Busy/$\overline{\text{Busy}}$	Input data can be loaded any time the $\overline{\text{Busy}}$ pulse is low or the Busy pulse is high.
Unused Digits	The inputs for unused digits may be left open. Data will not be recorded in these positions.
+5V dc Output	A +5V dc output is available to power external circuitry. The total current drain should not exceed 50 mA.

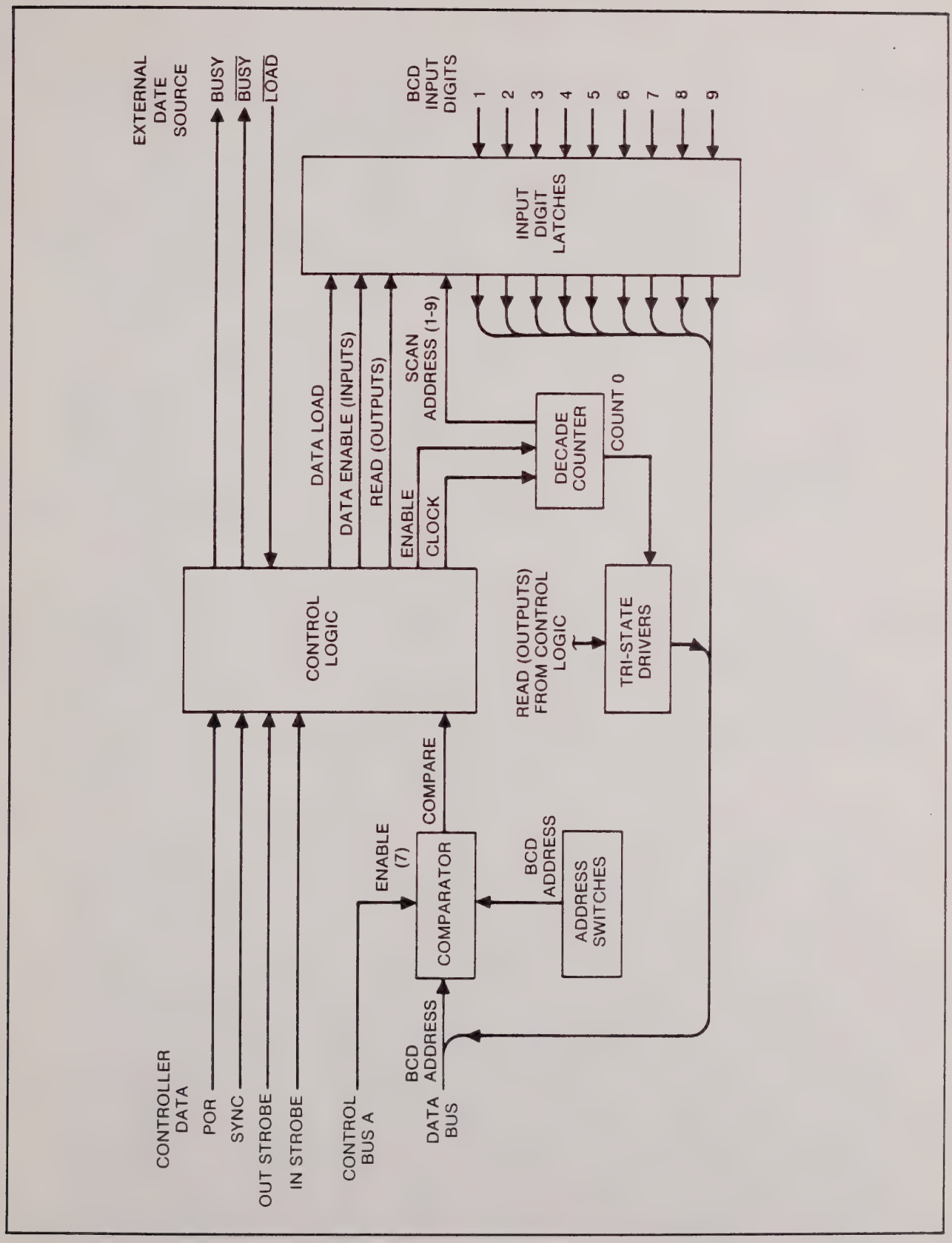


Figure 616-2. Digital Input PCB Simplified Block Diagram

Input PCB in character-parallel format. An externally generated load pulse enters the parallel digits into a series of storage registers on the pcb. This stored data is then solicited via Control Bus A and read into the controller via the Data Bus. While the controller is reading data from the registers, a complementary pair of Busy flags is generated by the Digital Input PCB. These flags indicate the duration of the read period and are intended for use in providing the external data sources with legal load-period timing. This is necessary since the stortage registers cannot be updated while they are being read by the controller. All data and control inputs/outputs to the external data source are positive-true DTL/TTL logic levels.

616-19. Operation can be logically divided into two sequences; load and read. Load sequences are initiated by an externally generated Load command and can be executed any time a read sequence is not in progress. Complementary Busy flags are provided to indicate the legal load periods. Read sequences are initiated under the direction of the controller and include an address verification routine to ensure that the proper output pcb has been addressed. This is necessary since up to three Digital Input PCBS can be installed in a data logger.

616-20. A load sequence is initiated when a low level (>-50 us) is applied to the Load input of the Digital Input PCB. If a read sequence is not in progress, the next Sync pulse from the controller sets a pair of flip-flops in the control logic. This generates the leading edge of the data load pulse causing all nine digits of external input data to be loaded into a series of parallel input digit latches. On the next Sync pulse the data load pulse is terminated. When the external Load input returns high the control logic is reset, thereby arming the Input Register for the next load sequence.

616-21. A read sequence is initated when the controller places a binary coded 7 onto the Control Bus A and the Digital Input PCBs switch address (0, 1, or 2) onto the Data Bus. When the combination of these inputs is present a compare input is presented to the control logic. On the rising edge of the subsequent Out strobe, the control logic accepts the compare input to enable the read sequence. As a result, the decade counter is enabled, an In strobe is enabled to serve as the counter's clock, and a read (outputs) signal is generated. The combination of the read (outputs) and the count 0 outputs enable a set of four tri-state drivers which place a binary coded zero onto the Data Bus. The controller recognizes this code as a valid address reply and responds by generating a series of In strobes. Each strobe advances the decade counter causing each of the nine input digit latches to be sequentially addressed. The controller reads each new character on the leading edge of the In strobe and advances the decade counter on the strobe's trailing edge. After the ninth character has been read the binary coded 7 is removed from Control Bus A. This effectively resets the control logic by clearing the enable and read outputs.

616-22. MAINTENANCE

616-23. Access Information

616-24. Refer to the installation instructions given earlier in this section for Digital Input Option access information. Remove the rear panel input connector before attempting to remove the pcb from the data logger.

616-25. Fuse Replacement

616-26. A 1/4 amp, fast-acting fuse is located on the component side of the Digital Input PCB Assembly. If replacement is necessary, pull the old fuse from the fuse clip and press a new one into place.

616-27. Performance Test

616-28. The Digital Input Option is most easily tested under normal operating conditions. That is, installed in a functional data logger, and connected to its input data source (as provided by the user). When any scan sequence is executed and the internal printer is enabled, the digital input data source should be printed following the fixed data entry (2240A) or the scan counter entry (2200A). If two or three Digital Input Option PCBs are installed in the same unit, input data will be printed in the order assigned by the address switch settings (see Installation instructions). If no data is printed, either the fuse on the pcb is blown, input data is not being loaded correctly, or the board address has not been set correctly. If some, but not all, characters of entered data are printed incorrectly, the Input Registers on the Digital Input PCB are probably defective.

616-29. LIST OF REPLACEABLE PARTS

616-30. A list of replaceable parts for the Digital Input Option is given in Table 616-5. Refer to Section 5 of this manual for ordering information.

CAUTION

Indicated devices are subject to damage by static discharge.

Option -17
Remote Programming Interface

617-1. GENERAL

617-2. EIA Standard RS-232-C provides the electronics industry with the ground rules necessary for independent manufacturers to design and produce both data terminal and data communication equipment that conforms to a common interface requirement. As a

TABLE 616-5 LIST OF REPLACEABLE PARTS NOT AVAILABLE

result, a data communications system can be formed by connecting an RS-232-C data terminal (such as, the 2240B) to an RS-232-C data communication peripheral (such as, a TTY, MODEM, computer, etc.). This works fine on paper. However, in practice, the user must be aware of the subtleties of binary data interchange to ensure that any two pieces of RS-232-C equipment will be compatible. For example, the two instruments must share at least one of the features from each of the following characteristics:

1. Timing Format - Synchronous or Asynchronous.

2. Transmission Mode - Simplex, Half-duplex, or Full duplex.

3. Baud Rate (bits per second) - 110, 150, 300, 600, 1200, 1800, 2400, 4800, 9600.

4. Bits Per Character - 5, 6, 7, 8.

5. Parity Bit - Odd, Even, High, Low, Not Used.

6. Data Interface Levels - EIA or 20 mA Current Loop.

617-3. Timing formats conforming to both synchronous and asynchronous operation are shown in Figure 617-1. In asynchronous operation each character is bracketed by both start and stop bits. These bits separate the characters and synchronize both the transmission and receipt of data. When data is not being sent the data line is held high. In synchronous operation a sync character is sent prior to each data stream (a data stream usually consists of a block of characters). When the line is idle a fill or sync character is continuously transmitted.

617-4. Transmission mode is an overall system requirement. It defines the communication ability of both instruments in the system configuration. Simplex indicates data transmission in one direction only. Half-duplex permits two way communication, but not simultaneously. Simultaneous transmission of data in both directions defines the full duplex system. Obviously, an instrument capable of full duplex operation can be downgraded to simplex operation. However, the reverse is not possible without degrading the system capability.

617-5. Baud rate is usually selectable on the RS-232-C INterface. If it is not, the manufacturer usually offers a choice when the instrument is purchased.

617-6. Character format (bits per character and parity) is somewhat flexible between instruments. Investigate the requirement of both instruments before committing either to a system configuration.

617-7. Data interface levels can occur as either EIA voltage levels or as a 20 mA current loop. At times, an interface offers

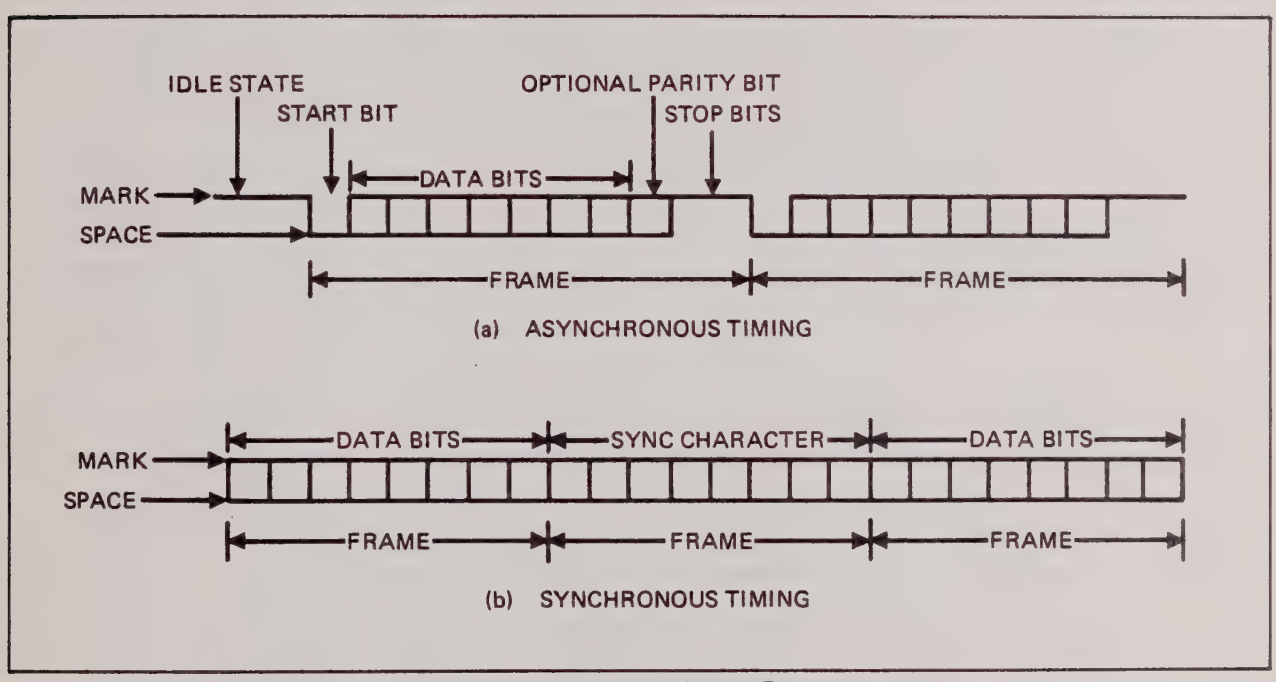


Figure 617-1. RS-232-C Timing Formats

both simultaneously. The 20 mA current loop is used almost exclusively for teletypewriter, or paper tape punch/reader interface. EIA voltage levels are: 1 or OFF = -15 to -3V dc, 0 or ON = +3 to +15V dc.

617-8. INTRODUCTION

617-9. The Remote Programming Option (-17) is designed to interface the Model 2240B Data Logger with an external, RS-232-C/20 mA current loop compatible data communication instrument, such as a TTY, MODEM, computer, CRT, etc. It features asynchronous timing, full duplex capability, selectable baud rate, choice of EIA of 20 mA current loop data levels, selectable parity for both transmit and receive, selectable character format (bits per character) and selectable output data format (lines per record, etc.). In addition, a unique address code can be assigned to the interface pcb. This code allows the interface to ignore all data not preceded by its assigned address character.

617-10. Option -17 is available in a variety of configurations as shown in Table 617-1. Order by model number and description. (Interface cable detail is given later under Operating Notes.)

617-11. SPECIFICATIONS

617-12. Specifications for the -17 Option are as follows:

Timing Format ... Asynchronous
Output Format ... Bit-Serial
Output Code ..... Seven level ASCII
Data Buffer 16-characters
Baud Rates 110, 150, 300, 600, 1200, 1800, 2400, 4500, 9600

Operating Power . Derived from data logger
Operating Temp .. 0 to 50°C

617-13. INSTALLATION

617-14 Interface PCB

617-15. The Remote Programming PCB Assembly can be installed in any one of the data logger I/O slots shown in Figure 617-2. Use the following procedure to install the pcb:

WARNING

REMOVE LINE POWER AND ALL OTHER HIGH VOLTAGE INPUTS TO THE DATA LOGGER BEFORE STARTING THIS PROCEDURE.

1. Set the data logger POWER switch to OFF.

Table 617–1. Option –17 Configurations

MODEL NO.	DESCRIPTION
2240B–17A	Data Communication Interface Kit (PCB and Cable)
2240B–17B	Data Terminal Interface Kit (PCB and Cable)
2240B–17C	Current Loop (20 mA) Interface Kit (PCB and Cable)
2240B–17G	Interface PCB (no cable)
2200A–7008	Interface Cable (–17A), Data Communications
2200A–7009	Interface Cable (–17B), Data Terminal
2200A–7010	Interface Cable (–17C), Current Loop (20 mA)

2. Remove the top cover from the data logger.

3. Locate S3 on the pcb as shown in Figure 617-2. This switch is used to establish the format of transmitted data.

4. With reference to Table 617-2, set 1 through 4 of S3 to establish the desired format.

5. Locate S4 on the pcb as shown in Figure 617-2. This switch is used to establish the baud rate of both transmitted and received data.

6. With reference to Table 617-3, set 1 through 4 of S4 to establish the desired baud rate.

7. Locate S2 on the pcb as shown in Figure 617-2. S2 is used to assign a unique address code to the pcb. This code allows the pcb to ignore all command (data) strings that are not preceded by the code.

8. With reference to Table 617-4, set 2 through 4 of S2 to assign the desired address character.

9. Locate S1 on the pcb as shown in Figure 617-2.

10. Refer to Table 617-5 and set 1 through 4 of S1 to define the interface and data characteristics of the pcb.

11. Align the Remote Programming PCB in the selected I/O slot so that the female connector is toward the rear of the data logger, and the small board-edge connector is toward the bottom of the unit. Push the pcb straight down onto the mating connector.

12. After the pcb is installed, install the top cover.

617-16. Interface Cable

617-17. The peripheral is connected to the Remote Programming PCB by means of the interface cable. Connector P52 connects to the pcb, and P1 connects to the peripheral. Before actually installing the cable, refer to the interface information given later under Operating Notes and check to ensure that all required signal lines are present in the interface connection. If the 20 mA current loop interface is used, refer to Operating Notes for connection information.

617-18. OPERATING NOTES

617-19. The following paragraphs describe various conditions

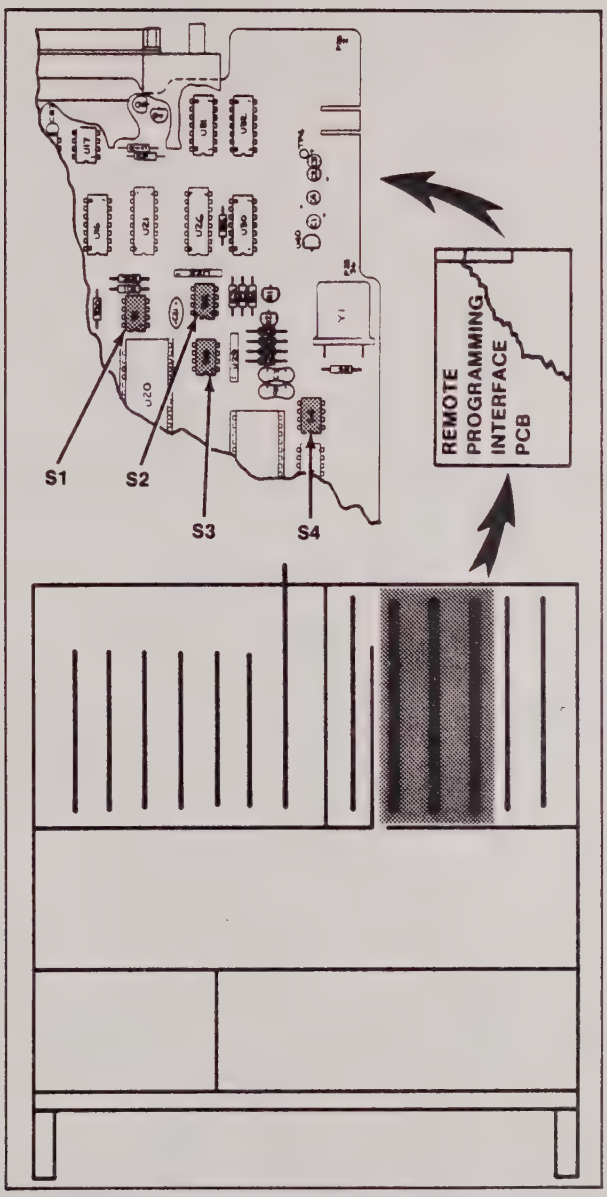


Figure 617-2. Remote Programming Interface PCB, Installation and Switch Locations

Table 617-2. S3 Switch Settings

S3 DEFINES THE FORMAT OF TRANSMITTED DATA CHARACTERS					
CHARACTER FORMAT			PARITY		
Bits Per Character	Position		Function	Position	
	3	2		1	4
5	On	On	Odd	On	On
6	On	Off	Even	Off	On
7	Off	On	None	X	Off
8	Off	Off	X = May be Off or On		

Table 617-3. S4 Switch Settings

S4 DEFINES THE BAUD RATE OF TRANSMITTED AND RECEIVED DATA				
BAUD RATE *	SWITCH POSITIONS			
	1	2	3	4
110	Off	Off	Off	Off
150	Off	Off	Off	On
300	Off	Off	On	Off
600	On	Off	Off	On
1200	Off	On	Off	Off
1800	Off	On	Off	On
2400	On	Off	Off	Off
4800	Off	On	On	Off
9600	Off	On	On	On

**One stop bit accompanies each character except at 110 baud where 2 stop bits are used.*

Table 617-4. S2 Switch Settings

S2 DEFINES ADDRESS CODE ASSIGNED TO REMOTE PROGRAMMING PCB						
ADDRESS CHARACTER		POSITION				S2 CODE (HEX)
ASCII	Hex	4	3	2	1	
!	21	Off	Off	Off	See Note	0
"	22	On	Off	Off		1
#	23	Off	On	Off		2
$	24	On	On	Off		3
%	25	Off	Off	On		4
&	26	On	Off	On		5
No Address	—	Off	On	On		6
Auto Answer	—	On	On	On		7

Note: S2 - P1, when set to ON, will cause a delay of ≈250 ms after each CR LF. When set to OFF no delay will occur.

Table 617-5. S1 Switch Settings

S1 DEFINES INTERFACE AND DATA CHARACTERISTICS		
POSITION	FUNCTION	SETTING
1	Controls echo of received characters to the peripheral.	On = Echo Off = No Echo
2*	Selects number of analog readings per line (output data).	On = Four Off = One
3**	Used in conjunction with U10 and U11 to alter the standard output format.	On = Special Off = Standard
4	Selects I/O data levels. 20mA Current Loop or EIA.	On = EIA Off = 20mA

*With -18, ON selects number of R.D.L. specified by -18, OFF = 1.
**Option -18.

that should be considered before attempting to operate the Remote Programming Option.

617-20. Interface Cables

617-21. One of three user specified, interface cables may be used with the Remote Programming Interface; i.e., -17A, -17B, or -17C. The 17A and 17B cables are designed for use with an RS-232-C peripheral employing EIA data levels. The -17A cable has a male connector suitable for use with data communication equipment. The -17B cable has a female connector and is compatible with data terminal equipment. Signal and connection details are given in Table 617-6. Notice that all pins relating to the 20 mA current loop interface (*) are not connected (in cables 17A and 17B). Equipment requiring a 20 mA current loop interface must, therefore, use the -17C cable. Connection details for this cable are given later in this section under Current Loop Interface.

617-22. Control Signals

617-23. All of the control signals specified in RS-232-C which have been implemented in the -17 Option are listed and described in the following paragraphs.

1. CD - Data Terminal Ready - pin 20
2. CA - Request to Send - pin 4
3. CE - Ring Indicator - pin 22
4. CF - Received Line Signal Detector - pin 8
5. CB - Clear to Send - pin 5
6. CC - Data Set Ready - pin 6

617-24. Signals CF, CB, CC must be generated by the peripheral for all pcb address codes (S2) other than 7. If address 7 is assigned to the pcb, the peripheral must also supply signal CE. If CA and CD or CE are not used, they should be left open. When CF, CB, and CC are not required they should be tied to an RS-232-C "ON" state (+3 to +15V dc with respect to signal common).

617-25. The automatic answer or switched service mode of operation is enabled when address code 7 is assigned to the Remote Programming PCB. In this mode the pcb polls Ring Indicator line (CE) for activity. When CE is turned on, the pcb sets its Data Terminal Ready line (CD) to on. Then, after a 4-second delay it checks for both Data Set Ready (CC) and Received Line Signal Detector (CF) to be on, and CE to be off. When this condition is met, the pcb sets the Request to Send line (CA) to on and then

Table 617-6. Interface Cable Signals and Connections

REMOTE PROGRAMMING PCB		INTERFACE CABLE			
Signal	J52	P52	▷	P1	
				17A	17B, 17D
Protective Ground (Chassis)	1	1	→	1	1
Transmitted Data	2	2	→	2	3
Received Data	3	3	→	3	2
Request to Send	4	4	→	4	5
Clear to Send	5	5	→	5	4
Data Set Ready	6	6	→	6	20
Signal Ground	7	7	→	7	7
Received Line Signal Detector	8	8	→	8	20
Not Used	9	9	→	9	9
Not Used	10	10	→	10	10
I2 Current Source	11	11	•	11	11
$-I_T$ Transmit (20mA)	12	12	•	12	12
$+I_R$ Receive (20mA)	13	13	•	13	13
$-I_R$ Receive (20mA)	14	14	•	14	14
Not Used	15	15	→	15	15
$+I_T$ Transmit (20mA)	16	16	•	16	16
Not Used	17	17	→	17	17
-I Current Sink	18	18	•	18	18
-I Current Sink	19	19	•	19	19
Data Terminal Ready	20	20	→	20	6,8
Not Used	21	21	→	21	21
Ring Indicator	22	22	→	22	22
Not Used	23	23	→	23	23
Not Used	24	24	→	24	24
I1 Current Source	25	25	•	25	25

▷→ = *Pins connected.*

* = *No connection between pins.*

checks the Clear to Send Line (CB). If CB is on, a connection is made. Otherwise, no connection is made and the pcb sets CA and CD to off, and returns to polling the Ring Indicator (CE).

617-26. The dedicated line mode of operation is used for all address codes other than 7. In this mode the pcb sets the Data Terminal Ready line (CD) to the on state when power occurs. It then polls for Data Set Ready (CC), and if on, sets the Request to Send line (CA) to on. In order, it then checks the Clear to Send (CB) and Received Line Signal Detector (CF). If both are on, then a data connection is made and the pcb is ready to receive data.

617-27. When a -17 Remote Programming Interface is installed in the 2240C Data Logger, the following control lines must be connected to an RS-232-C logic ON state (+3V to +15V) to insure proper interface operation.

Data Set Ready (CC). . . . . .J52, Pin 6
Clear To Send (CB) . . . . . .J52, Pin 5
Received Line Signal Detector (CF) . .J52, Pin 8

617-28. Most peripheral devices provide the proper signals. If the Data Logger is to be operated without a peripheral device, the control lines can be tied to J52, Pin 20, Date Terminal Ready.

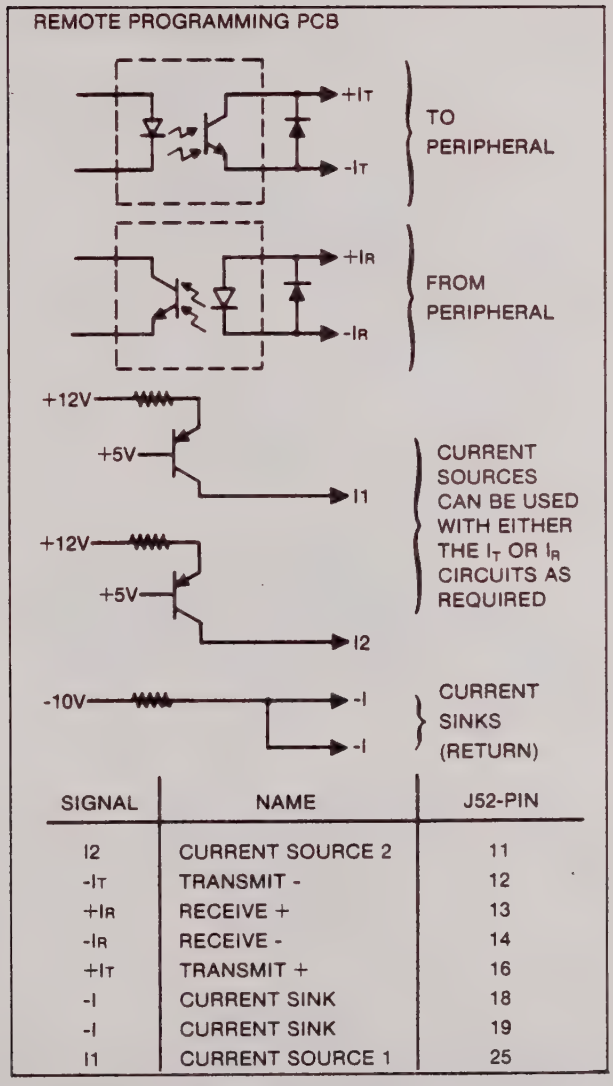
617-29. Current Loop Interface

617-30. The Remote Programming PCB is designed to transmit/receive data at either EIA voltage levels or 20 mA current loop levels. Switch S1, position 4, is used to select the desired data levels (see Installation Instructions). If the current loop levels are to be used, the -17C version of the interface cable must be employed. The -17 design is somewhat flexible in that it allows the current sources (transmit and receive) to be derived from either the Remote Programming PCB of the peripheral. Figure 617-3 illustrates the currrent loop I/O capabilities provided on the Remote Programming PCB. An example of current loop interface with a teletypewriter (Model ASR-33) is shown in Figure 617-4. When multiple data loggers are to be interfaced with a single peripheral current loop connections similar to those shown in Figure 617-5 are recommended.

617-31. Programming Format

617-32. The Remote Programming PCB is capable of accepting a series or string of alpha numeric characters and interpreting them as control/program data. These data (command) strings, when properly formatted, enable the remote peripheral to program the following data logger functions:

1. Scan Control



SIGNAL	NAME	J52-PIN
I2	CURRENT SOURCE 2	11
-IT	TRANSMIT -	12
+IR	RECEIVE +	13
-IR	RECEIVE -	14
+IT	TRANSMIT +	16
-I	CURRENT SINK	18
-I	CURRENT SINK	19
I1	CURRENT SOURCE 1	25

Figure 617-3. Current Loop Provisions on Remote Programming PCB

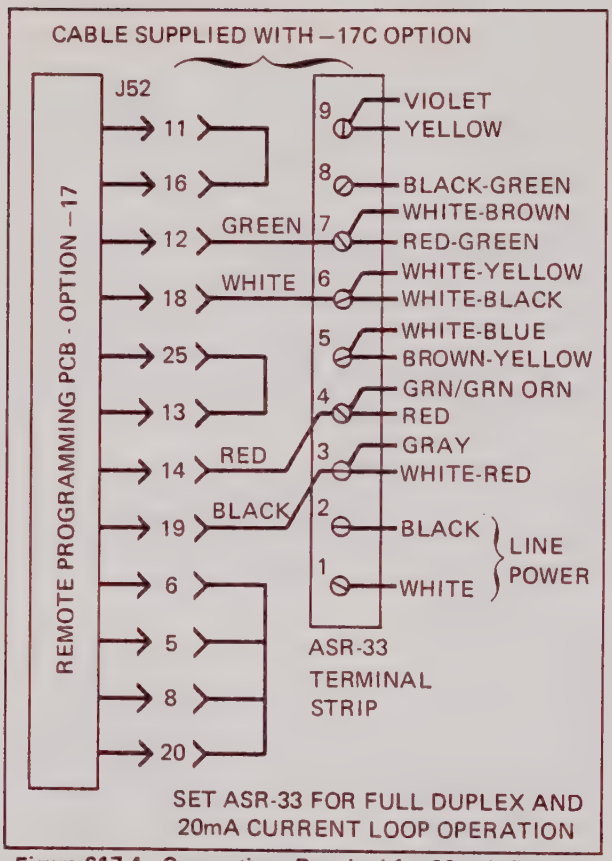


Figure 617-4. Connections Required for 20 mA Current Loop Interface with Model ASR-33 Teletypewriter

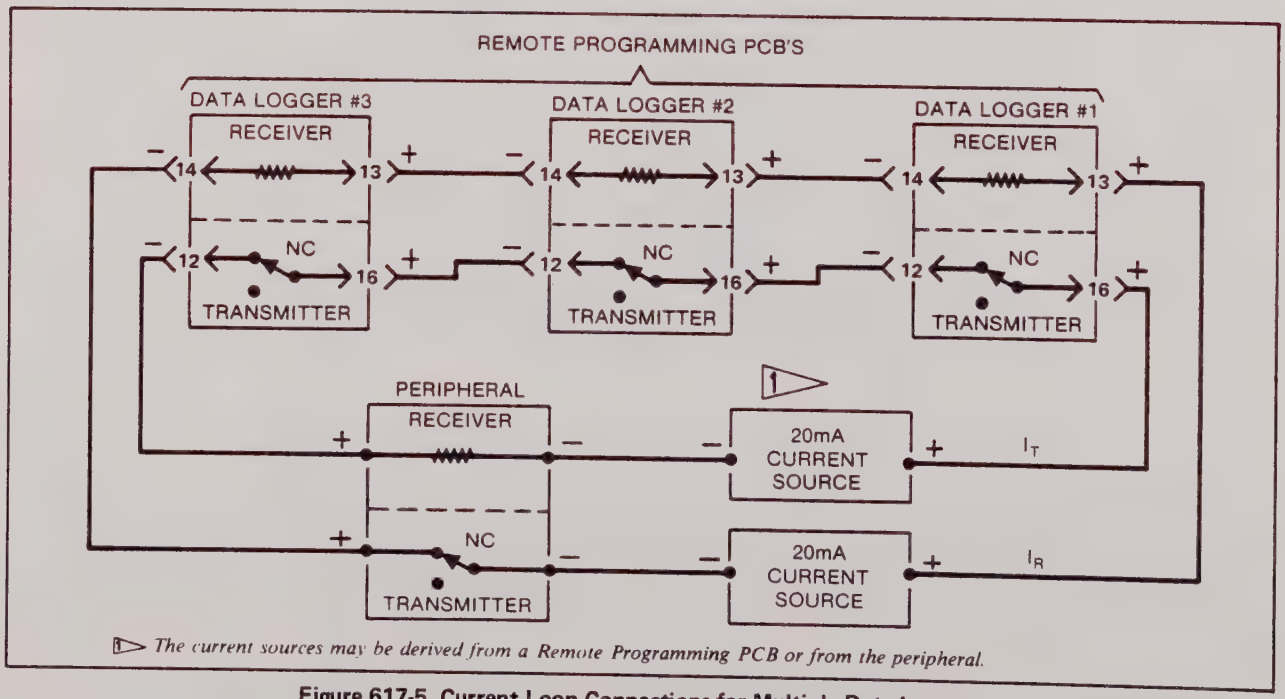


Figure 617-5. Current Loop Connections for Multiple Data Loggers

2. Output Control

3. Time

4. Scan Format

5. Channel Programming

6. Limits Programming

617-33. The format of the command string is shown in Figure 617-6. It consists of an address character, a command character, a numeric data field, and a carriage return terminator. The address character must correspond to that assigned (by #S2) to the interfaced Remote Programming PCB. An alphabetic command character follows to define the function to be programmed (scan control, output control, etc.). The commanded function is then programmed by a series of numeric characters. These characters represent a variable length numeric field and may contain a number of delimiters in the form of commas (,). After the numeric field is completed the command string is both terminated and executed by a carriage return (CR) character.

NOTE

A delimiter cannot be used for concatenation of command strings. Each string must be individually addressed and terminated.

617-34. A complete list of command characters and their associated numeric fields are given in Table 617-7. Proper formatting of a typical programming sequence is shown in Table 617-8.

617-35. Output Format

617-36. Output data from the interface pcb is recorded at the peripheral in the standard format shown in Table 617-9. A switch on the interface pcb (S1 position 2) allows selection (and printing) of either one or four measurement data readings per line.

617-37. Special formats are available on request (2240B-18, Special Output Format Option) and require the use of IC U10 (and depending on the format required by the customer, may include IC U11) with a custom program. The format variations are limited to those listed below. When ordering a special format, specify the variations using a form similar to that in Figure 617-7.

1. Data in any column can be deleted from any output field.

FIGURE 617-6. TABLES 617-7, -8, and -9 NOT AVAILABLE

1. **SUBSTITUTED OR DELETED CHARACTERS (Specify one ASCII character for each. If none is desired, so specify):**

   Scan Begin Character = ____ , Scan End Character = _____

2. **READINGS PER LINE (switch selectable)**

   1 or _____ (1 through 16)

3. **DELETE THE FOLLOWING CHARACTER COLUMNS FROM THE DATA FIELDS SHOWN BELOW.**

   (Mark 'X' in columns to be deleted).

DATA FIELD	COLUMN																	
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
TIME OF YEAR																		
FIXED DATA																		
DIGITAL INPUT DATA																		
MEASUREMENT DATA							ANALOG DATA *											

4. **USE SUBSTITUTE CHARACTERS IN THE OUTPUT DATA FIELDS SHOWN BELOW.**

   (List desired characters in the column provided). Substitution of CR or LF applies to all data fields.

DATA FIELD	COLUMN	STANDARD CHARACTER	SUBSTITUTE CHARACTER
TIME OF YEAR	4, 7 and 10	: (Colon)	
DIGITAL INPUT	3	SPACE	
MEASUREMENT DATA	4	>	
	4	<	
	4	SPACE	
	12	SPACE	
	12	m	
	12	SPACE	
	12	SPACE	
	12 and 13	*	
	13	V	
	13	V	
	13	F	
	13	C	
	14	O	
	14	B	
	15	L	
	15	T	
	14 and 15	SPACE	
ALL	—	CR	
	—	LF	

Figure 617-7. Special Format Instructions for 2240B–18 Option

2. Two characters can be substituted in the scan record; one at the beginning of the scan (prior to time of year), and one at the end of the last measurement data field (following LF).

3. Character substitution is possible in some output fields. If an ASCII character is substituted for either the CR or LF, that character will appear in all output fields.

4. The * in columns 12 and 13 of the measurement data field can only be substituted as a pair. The same is true of the space character in columns 14 and 15.

5. The number of switch selectable measurement readings per line can be changed from one or four to one or n, where n is any integer from 1 through 16.

6. When more than one analog measurement is recorded per line, they are separated by two spaces. Either one or both spaces may be deleted.

617-38. OPERATION

617-39. Once installed, the Remote Programming Option requires no operator attention other than ensuring that normal turn-on procedures are observed for both the 2240C and its peripheral. Select the remote mode of operation either manually or remotely as required by the position of switch #1 on the 2240C's A3 Controller PCB. (See Section 2, Figure 2-6 of the 2240C Instruction Manual.) Follow the programming format given earlier to control the operation of the 2240C. Each of the remote programming functions correspond to the manual functions described in Section 2 of the 2240C Instruction Manual.

617-40. THEORY OF OPERATION

617-41. The Remote Programming PCB, as shown in Figure 617-8, is a microprocessor based subsystem which functions as an A3 Controller peripheral to provide the interface necessary to transfer 2240C program and output data to and from a remote, digital I/O, data terminal type device. Any one of several types of remote data terminal instruments can be accommodated by the interface. Among these are: a 20 mA current loop teleprinter, paper tape reader/punch, or any RS-232-C compatible device capable of qualifying as a data terminal. Once the data terminal equipment is defined, the interface pcb is tailored to meet the interface requirements by setting a series of switches on the pcb. (See Installation Instructions for switch settings as they apply to this option.) These settings are read and stored by the MPU each time the data logger is turned on.

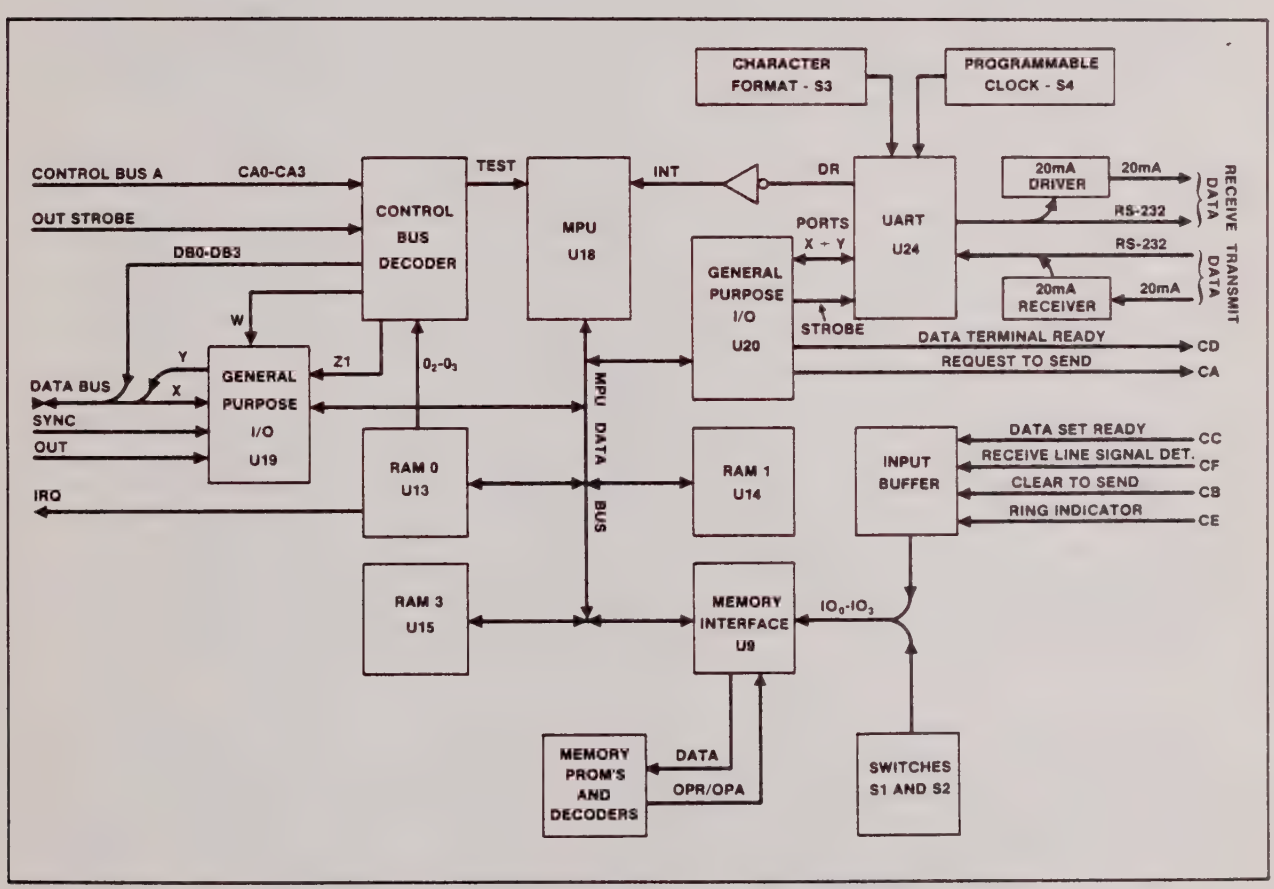


Figure 617-8. Remote Programming Option Simplified Block Diagram

617-42. Operation of the Remote Programming PCB Assembly can be functionally divided into two sequences: transmit and receive. The transmit sequence involves the transfer of programming information from the data terminal to the A3 Controller in the 2240C. Conversely, the receive sequence involves the transfer of output data (scan and measurement data) from the data logger to the data terminal equipment. In both cases, each I/O word (up to 16 characters) is temporarily stored on the interface pcb before being transferred to its final destination. This allows the interface pcb to synchronize its transfer operations with either A3 Controller of the data terminal, as required.

617-43. Transmit Sequence

617-44. Character-serial program data from the data terminal is received at the Remote Programming PCB as either 20 mA current levels or EIA (RS-232-C) voltage levels. The data is level shifted and/or buffered, and then used as the data input to a Universal Asynchronous Receiver Transmitter (UART). Data is received at the baud rate defined by switch S4, and in the format defined by switch S3. When a complete character is received, the UART generates a high (+5V dc) DR output. DR is inverted for use as the INT input to the MPU (microprocessor unit). In response to an INT input the MPU reads the parallel UART output character (I/O) via the General Purpose Input/Output (GP I/O) device U20 and the MPU Data Bus. The UART is prompted to output data by a strobe received from the GP I/O (U20). This strobe is initiated by the MPU via the Data Bus. After the character is read by the MPU, the strobe input resets the UART's DR output, and thus removes the INT input from the MPU.

617-45. Transmit data characters received by the MPU are transferred to and stored in RAM0. When a complete command (up to 16 characters) has been assembled, the MPU checks it for errors and formats it for use by the data logger's A3 Controller, Then RAM0 initiates and IRQ (Interrupt Request) to notify the A3 Controller that the data is ready to be processed.

617-46. In response to the IRQ the A3 Controller begins to poll the various I/O pcb's to determine which pcb requested the interrupt and what service, if any, is required. To poll the Remote Programming PCB the A3 Controller places a binary coded 6 onto Control Bus A (CA0-CA3). The pcb detects its code and responds with its current status via the Data Bus. The possible response codes and their meanings are shown in Table 617-10. When the Remote Programming PCB has initiated the interrupt request (IRQ), it confirms its action by placing a binary coded 7 on the Data Bus as a response code.

617-47. When the A3 Controller is ready to receive data from the Remote Programming PCB, it places a binary coded 14 onto Control Bus A. The code is detected by the Control Bus Decoder which, in turn, enables data from port Y of the GP I/O (U19) to be placed

Table 617-10. Remote Programming PCB Response Codes

BINARY CODED STATUS RESPONSE	DEFINITION
6	Interrupt Request and Busy
7	Interrupt Request (IRQ)
14	Busy
15	Not Busy, No Interrupt

onto the Data Bus. Concurrently, the MPU, on every Sync pulse, reads port W of the GP I/O (U19). When it detects a data request code (binary coded 14), it proceeds to transfer 16 characters to the A3 Controller via port Y of the GP I/O (U19). At the end of the transfer, the Controller terminates the sequence by removing the binary coded 14 from the Control Bus.

617-48. Receive Sequence

617-49. When the A3 Controller is ready for the remote data terminal to receive data, it polls the status of the Remote Programming PCB by placing a binary coded 6 onto Control Bus A. If the pcb is not busy, it responds with a binary coded 15 via the Data Bus, and thereby prompts the controller to initiate a Receive Sequence.

617-50. The controller initiates a receive sequence by placing either a binary coded 4 or 11 onto Control Bus A. These codes are detected by the Control Bus Decoder on the Remote Programming PCB, and are used to indicate to the MPU (by driving its Test input high) that data is about to be received from the controller. As subsequent data characters appear on the Data Bus, they are serially loaded into port X of the GP I/O (U19) by pulse Z1 (Z1 is derived from the Out strobe, and is enabled when binary codes 4 or 11 are on Control Bus A).

617-51. A total of 16 data characters are involved in each Receive Sequence. As they are transferred to the GP I/O (U19) they are also stored in RAM0 for further processing. When the transfer is completed the controller removes the receive code (4 or 11) from Control Bus A to terminate the first phase of the Receive Sequence.

617-52. During the remainder of the Receive Sequence the MPU checks the content and format of the received data, and then, if all conditions at the data terminal are correct, formats the data for transfer to the data terminal. Before the transfer occurs the MPU polls the status of the UART and the data terminal input lines. If the UART is ready (TBRE and TRE output must be high), and the Received Line Signal Detector, the Clear to Send, and the Data Set Ready inputs are on, then data will be accepted by the UART. Each receive-data character is transformed into an ASCII seven-level character by the MPU before being presented to the UART via ports X and W of the GP I/O (U20). Strobe pulse Z0 is used to enter each serial character into the UART buffer. As each character is loaded, the correct parity (as determined by switch setting of S3) is assigned. Then the character is shifted (serial-by-bit, LSB first) out of the UART as output or receive data. Data from the pcb is level-shifted and buffered to provide a choice of RS-232-C voltage levels of 20 mA current levels as the data source to the data terminal.

617-53. MAINTENANCE

617-54. Access Information

617-55. Refer to the Installation Instructions given earlier in the subsection for Remote Programming PCB access information. Remove the rear panel output connector before attempting to remove the pcb from the data logger.

617-56. PERFORMANCE TEST

617-57. The Remote Programming PCB Assembly is most easily tested under normal operating conditions. That is, installed in a functional data logger and interfaced with its normal peripheral. Output data can then be checked by comparing data recorded on the internal printer with hard copy data derived from the external recording device. Similarly, the effects of remote programming can be compared to isolate malfunctions to the pcb level.

617-58. LIST OF REPLACEABLE PARTS

617-59. The lists of replaceable parts for the -17 Option are given in Tables 617-11 through 617-16. Refer to Section 5 of the data logger manual for ordering information.

CAUTION

Indicated devices are subject to damage by static discharge.

TABLES 617-11 THROUGH 617-6 LISTS OF REPLACEABLE PARTS NOT AVAILABLE

Option -23
Alarm Set Point Output

623-1. INTRODUCTION

623-2. Alarm Set Point Output (Option -23) is a plug-in pcb assembly designed to operate in any one of the data logger's I/O slots. Its function is to provide an external output when a measurement at any channel exceeds an assigned limit value. The output is in the form of 30 separate open-collector transistors. Each output is identified by number (1 through 30) on the pcb.

623-3. When Option -23 is used in the 2240C each of the 30 outputs correspond to 1 of 60 possible limit addresses. With switch S1 in the 1-30 position, the outputs correspond to the first 30 limit addresses. With switch S1 in the 31-60 position, the outputs correspond to the second 30 limit address. Two Alarms Outputs Options are necessary for 60 simultaneous Alarm outputs. An active (turned-on) output transistor indicates that the limit value of the corresponding limit address is assigned to the previously measured channel, and that the measurement exceeded the limit value. Memory included on the pcb maintains all limit-exceeded indications until a reset, either manual or remote, is received. The manual reset is located on the 2240C front panel above the power switch. A front panel LIMIT EXCEEDED lamp, located next to the RESET switch, flashes when one or more limit values have been exceeded.

623-4. When Option -23 is used in a 2200B switch S1 must be in the 1-30 position, and only 14 of the 30 outputs are used. Ten are used to denote a limit exceeded condition on individual channels or on blocks of 10 channels, depending upon the selected programming mode, individual or block. The remaining four outputs identify which of the four limits (assigned to that channel or block) has been exceeded. Thus, the 14 outputs are capable of identifying a total of 40 unique limits. Memory on the pcb maintains all limit-exceeded indications until a reset, either manual or remote, is received. The manual ALARM RESET switch is located on the 2200B front panel in the SCAN CONTROL switch group.

623-5. SPECIFICATIONS

623-6. Specifications for the Alarm Set Point Output (Option -23) are given in Table 623-1.

623-7. INSTALLATION

623-8. The Alarm Set Point Output PCB can be mounted in any one of the data logger's I/O slots, as shown in Figure 623-1. Install the pcb as follows:

WARNING

Table 623-1. Alarm Set Point Output Specifications

Compatibility	
2240B	Used in conjunction with Option -22
2200B	Used in conjunction with Option -34 (2200B-34)
Number of Outputs	30 open-collector outputs (one output for each limit value)
Uncommitted Relays	2 (These relays can be hard wired to any or all of the 30 set point outputs)
Open Collector Output Current	30 mA maximum
Relay Contact Rating	50V/1A (15 watts maximum)

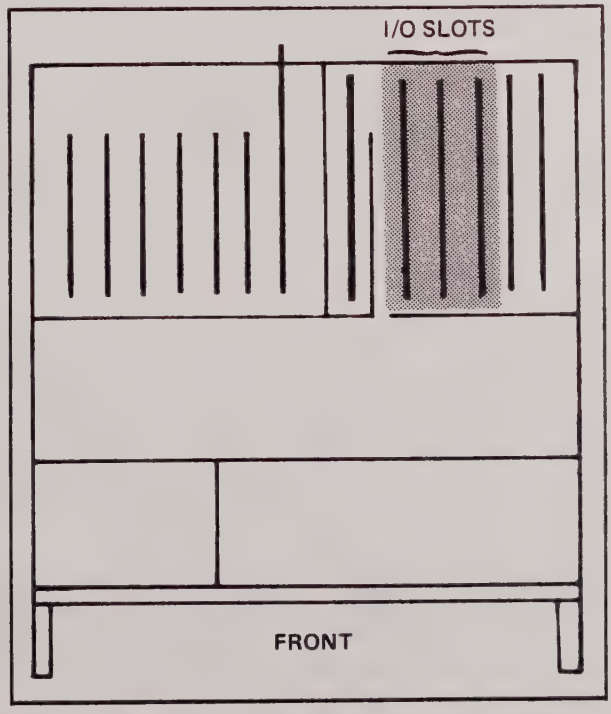


Figure 623-1. Alarm Set-Point Output, Installation Locations

REMOVE LINE POWER AND ALL OTHER HIGH VOLTAGE INPUTS TO THE DATA LOGGER BEFORE STARTING THIS PROCEDURE.

1. Set the data logger's POWER switch to OFF.

2. Remove the top cover from the data logger.

3. Refer to the Alarm Relays in later paragraph and ensure that the proper jumpers are installed.

4. Place switch S1 in the desired position (1-30 or 31-60).

5. Align the Alarm Set Point Output PCB in the selected I/O slot so that the large female connector is toward the rear of the data logger, and the small board-edge connector is toward the bottom of the unit. Push the pcb straight down onto the mating connector.

6. After the pcb is installed, install the top cover.

623-9. OPERATION

623-10. Once installed in the data logger, the Alarm Set Point Output requires no operator attention. However, certain considerations are necessary to properly access and utilize the alarm outputs. These considerations are covered in the following paragraphs.

623-11. Interface Connection

623-12. Remote connections to the Alarm Set Point Output PCB are completed through either General Interface Cable (2240A-7006) or a blank Interface Connector (2240A-7007). Either the cable or the connector attaches to the Alarm Set Output PCB connector at the rear of the data logger. Both the cable and connector are available as accessories and are described in this section (Section 6).

623-13. The user is responsible for completing the cable connections between the output connector and the remote input device. The pin connections of the Alarm Set Point Output's rear panel connector are given in Table 623-2, for both the 2200B and the 2240C.

623-14. Alarm Outputs

623-15. The alarm outputs are driven by 30 separate open-collector transistors. When a channel measurement exceeds the value of its assigned limit, the corresponding transistor turns on and pulls the appropriate alarm output to logic common.

The output is held low until it is either manually or externally reset. Each open-collector output is capable of sinking a maximum of 30 mA when turned on. The maximum VCE, when off is +25V dc. Power dissipation is 180 mW, maximum.

CAUTION

Use an external, isolated power supply to power devices driven by the alarm outputs.

623-16. The open-collector alarm outputs can be used to drive TTL-CMOS logic, LED's and/or relays. The recommended interface for each of these devices is shown in Figure 623-2. Notice that an external voltage supply must be used to drive the interface devices. This source should provide an isolated output so that its low terminal can be referenced to the data logger's logic common (unguarded). Otherwise a ground loop will result. A fuse is provided on the Alarm Set Point Output PCB to prevent possible damage in the event of ground loop currents. Fuse replacement details are given later under maintenance.

623-17. External Reset

623-18. The External Reset input responds to a low input supplied by a contact closure to logic common, or a low TTL logic level. The reset command must be equal to or exceed 2 us. A continuously low reset input holds 30 alarm transistors off regardless of the inputs from the data logger. When the reset is returned high, the alarm transistors are again allowed to respond to alarm data. This function allows a simple control loop to be established as a response to clear the command. The next scan of the data logger will determine if the command needs to be set again.

623-19. Alarm Relays

623-20. Two alarm relays, K1 and K2, are provided on the Alarm Set Point PCB. Normally, the relays are uncommitted. However, they can be assigned by the user to operate with any combination of alarm outputs. The assignments are made by installing a series of jumpers in the spaces provided on the pcb. Figure 623-3 defines the jumper locations. The square land patterns are numbered 1 through 30 and are common to the individual open collector outputs, 1 through 30. The round land patterns are common to the K1 and K2 Control Buses.

623-21. When jumper wires are installed, the collectors are tied to the Relay Buses in a wired OR configuration. See Figure 623-4A. Therefore, when either relay is operated, all alarm outputs common to the Relay Bus go low. If it is desirable to maintain the integrity of the individual alarm outputs while operating the control relays, install diodes in place of jumper wires. See Figure 623-4B.

Table 623-2. Option -23, I/O Connector Pin Assignments

PIN	SIGNAL				PIN	SIGNAL			
	2240B		2200B			2240B		2200B	
1		15			26		30		
2		14			27		29		
3		13			28		28		
4		12	ALARM		29		27		
5		11	CHANNEL or BLOCK		30		26		
6		10	9-99	9	31		25		
7		9	8	8	32		24		
8	ALARMS	8	7	7	33	ALARMS	23		
9		7	6	6	34		22		
10		6	5	5	35		21	ALARM	
11		5	4	4	36		20	LIMIT NUMBER	
12		4	3	3	37		19	4	
13		3	2	2	38		18	3	
14		2	1	1	39		17	2	
15		1	0	0	40		16	1	
16	Logic Common (Unguarded)				41	Logic Common (unguarded)			
17	N/C				42	N/C			
18	External Reset				43	N/C			
19	Relay 4 (Spare for contact)				44	Relay 4 (Spare for contact)			
20	N/C				45	N/C			
21	Relay 3 (Spare for contact)				46	Relay 3 (Spare for contact)			
22	N/C				47	N/C			
23	Relay 2 (contact)				48	Relay 2 (contact)			
24	N/C				49	N/C			
25	Relay 1 (contact)				50	Relay 1 (contact)			

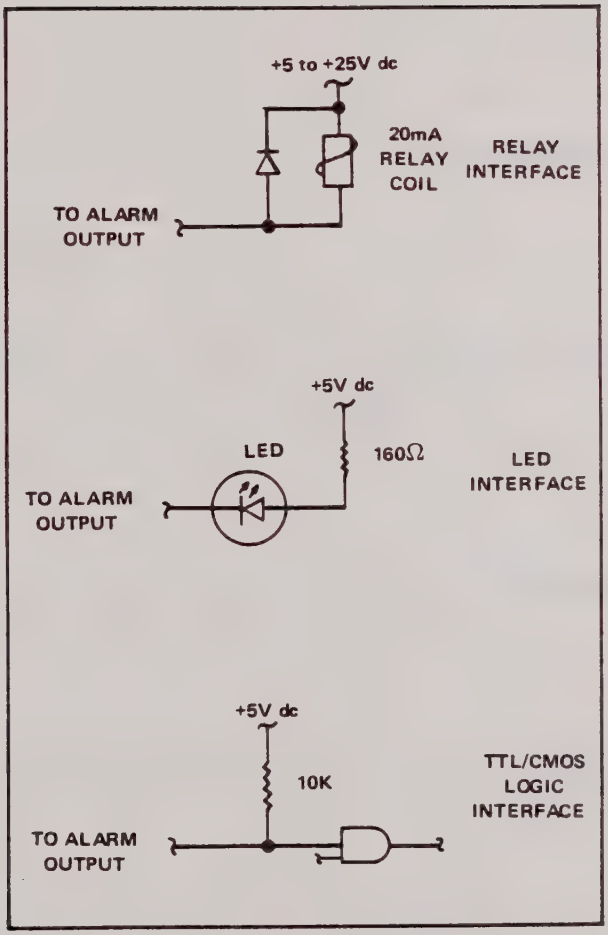


Figure 623-2. Recommended Output Alarm Interfaces

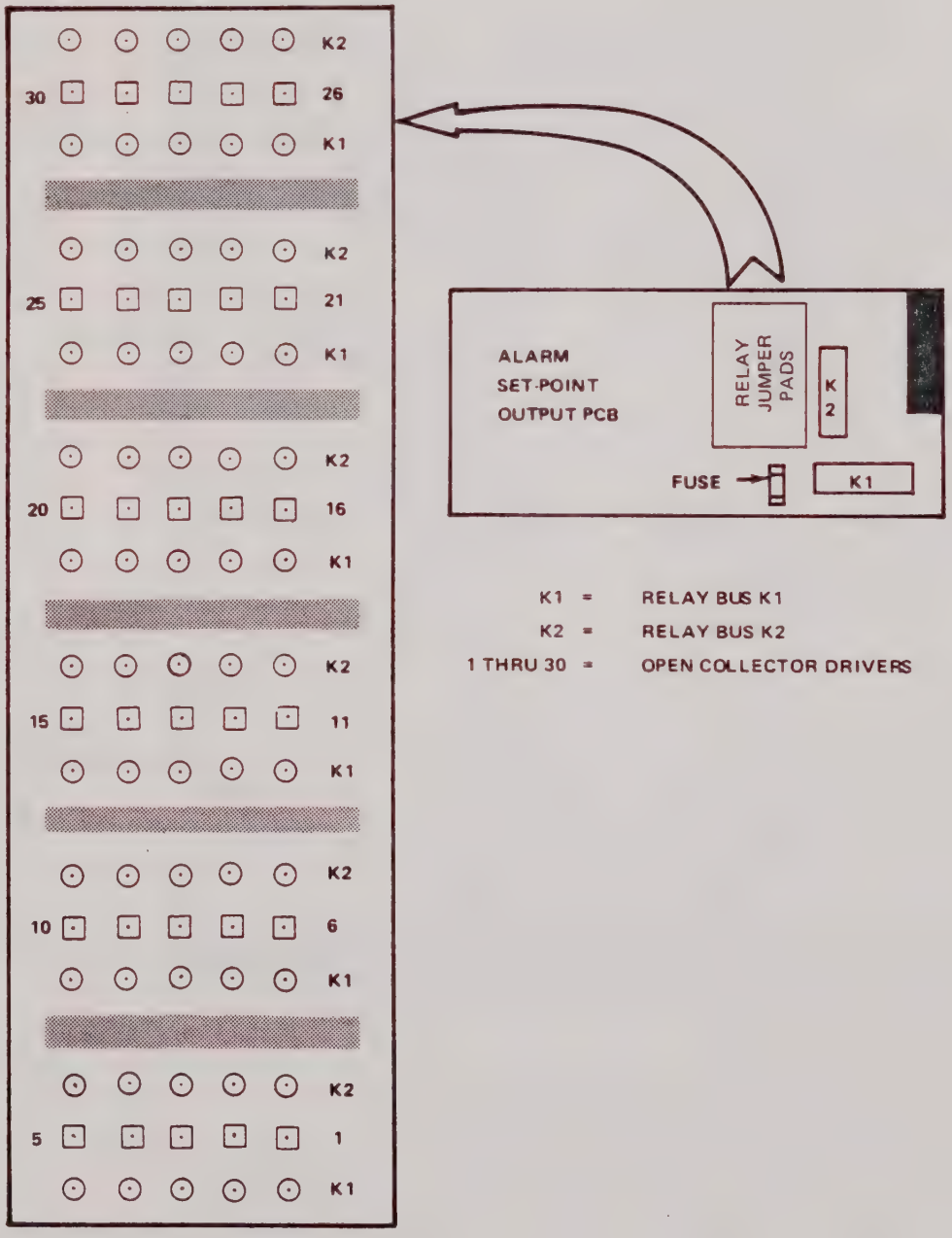


Figure 623-3. Alarm Set-Point Output PCB, Collector-to-Relay-Bus Jumper Locations

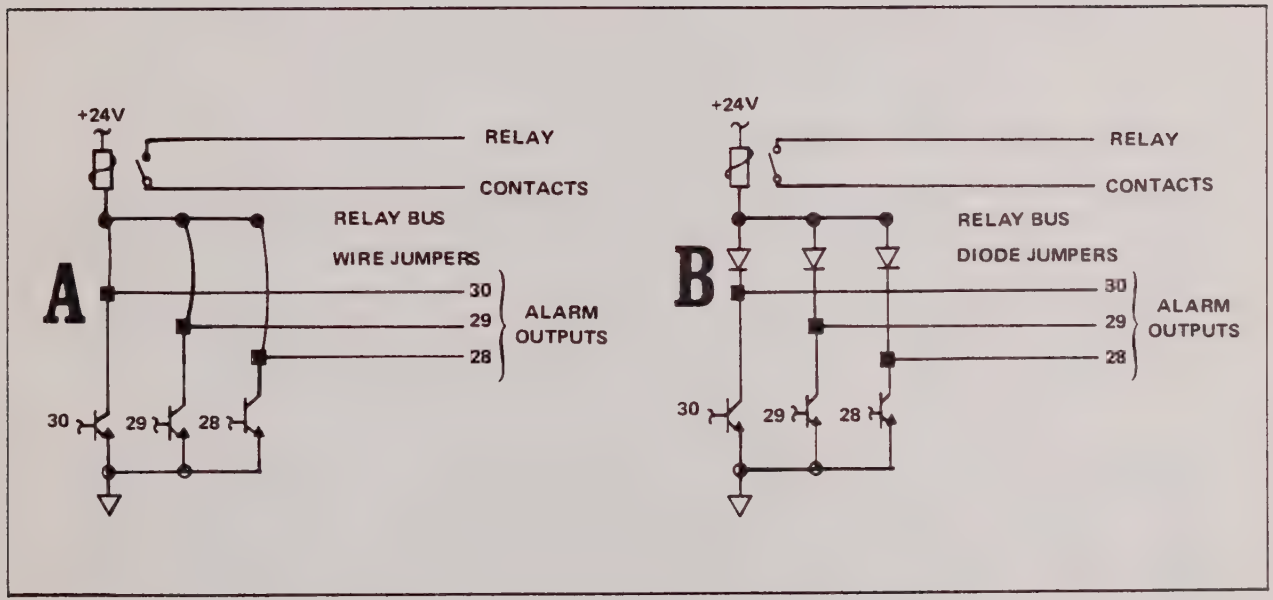


Figure 623-4. Collector-to-Relay-Bus Jumper Configurations

623-22. Circuitry is included on the Alarm Set Point Output PCB for the addition of two form-A, reed relays (K3 and K4), and their associated suppression diodes (CR3 and CR4). The I/O pin assignments for the K3 and K4 contacts are given in Table 623-2. The details necessary to install both relays are shown in Figure 623-5. The relay coils, reed switches, and suppression diodes are available from the John Fluke Mfg. Co., Inc. Use the following part numbers when ordering:

1.	Relay Coil	288357
2.	Reed Switch	413294
3.	Suppression Diode	203323

623-23. THEORY OF OPERATION

623-24. The Alarm Set Point Output PCB, as shown in Figure 623-6, functions as a remote data interface to provide high/low limit information to external indicators/devices. Limit exceeded indications from the pcb are in the form of open-collector transistors and relay contacts. Thirty transistor outputs and two relay outputs are provided. Jumper pads on the pcb allow the user to connect the two relay coils to any combination of the output transistors.

623-25. After the data logger completes each channel measurement, it compares the measured value with the assigned limit values, if any, for that channel. If the measured value falls within the assigned limit values, no action is taken at the Alarm Set Point Output PCB. However, if an out-of-limits indication is detected, the controller addresses the Alarm Set Point Output PCB via the Control Bus and provides it with the failed limit address. If switch S1 is in the 1-30 position, Option -23 is addressed by a binary coded 12 on the Control Bus. If S1 is in the 31-60 position, the Alarms Setpoint Output is addressed by a binary coded 4. A corresponding address register on the pcb stores the limit indication and, thereby turns on the appropriate output transistor as a limit exceeded indication.

623-26. Limit exceeded indications are supplied to the Alarm Set Point Output PCB as a maximum of two successive binary coded characters (0 through 15). The first character represents limit outputs 1 through 15 and the second represents limit outputs 16 through 30. If the exceeded limit is from group 16 through 30 (or 46 through 60 with S1 in the 31-60 position), the first character received on the Data Bus will be a binary zero (0000). A Strobe 1 pulse (derived from the Out strobe) is generated by the control logic causing the zero to be entered into a 4-bit latch and decoder. Prior to the next Out strobe a Sync pulse occurs causing the control logic to generate an Inhibit 1 pulse. This pulse allows the decoder to read the 4-bit latch and enable the appropriate output (1-of-16); in this case 0 (zero). Normally, a

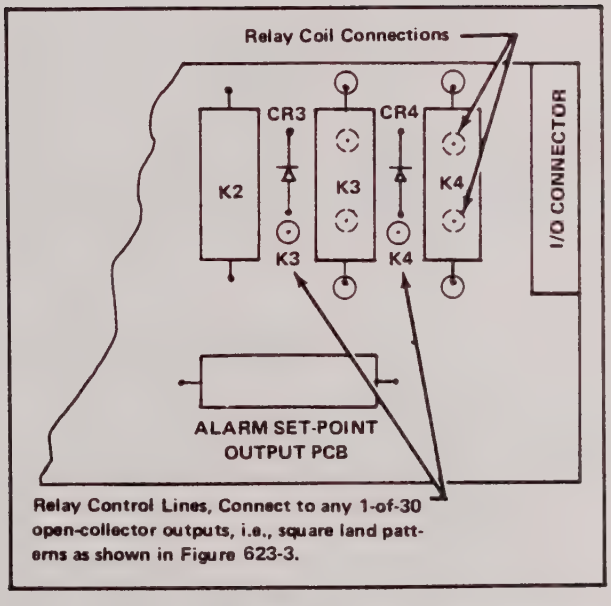


Figure 623-5. Locations for Mounting Reed Relays K3 and K4

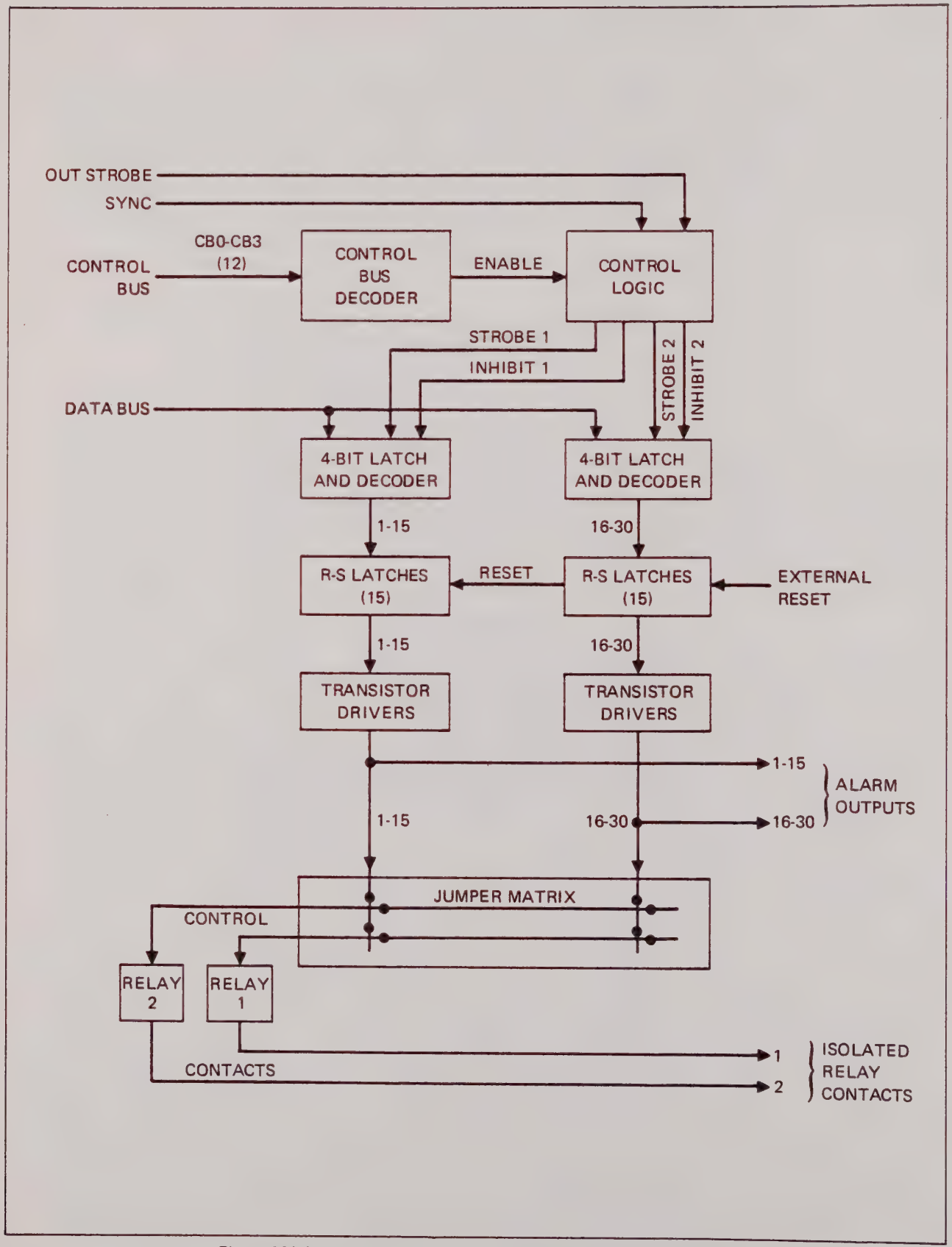


Figure 623-6. Alarm Set Point Output PCB, Simplified Block Diagram

decoder output of 1 through 15 would set 1 of the 15 R-S latches assigned to group 1 through 15. However, since the output is 0 (zero), all of the latches remain in their reset state.

623-27. The second address character is placed onto the Data Bus when the next Out strobe occurs. As before, a strobe pulse (Strobe 2) is generated by the control logic and the limit address is entered into a 4-bit latch and decoder. On the following Sync pulse the resulting Inhibit 2 pulse enables the decoded output (representing outputs 16 through 30 or 46 through 60) allowing it to set the corresponding R-S latch. The set-latch turns on the appropriate transistor driver to generate an alarm output.

623-28. When the limit exceeded indication is in the 1 through 15 (or 31-45) output group, the controller supplies only one character rather than two, as previously described. This is necessary since a zero entered into the 16 through 30 output section represents a reset for all 30 R-S latches. Reset occurs when the front panel RESET/ALARM RESET switch is pressed or when an external reset is entered at the Alarm Set Point Output PCB.

623-30. MAINTENANCE

623-30. Access Information

623-31. Refer to the installation instructions given earlier in Alarm Set Point Output PCB access information. Remove the rear panel output connector before attempting to remove the pcb from the data logger.

623-32. Fuse Replacement

623-33. A 1/2 amp, fast-acting fuse is located on the component side of the Alarm Set Point Output PCB Assembly. If replacement is necessary, pull out the old fuse from the fuse clip and press a new one into place.

623-34. Performance Test

623-35. The Alarm Set Point Output PCB Assembly is most easily tested under normal operating conditions, that is, installed in a functional data logger and connected to the output devices it normally drives. Each alarm output can then be checked for pass or fail indications by limit-address and limit-value programming. Use the MONITOR scan control mode to ensure constant observation of the channel to which the limit address in question is assigned. Also be sure to reset the Alarm Output PCB when a limit is exceeded (see Internal Reset earlier in this subsection).

623-36. LIST OF REPLACEABLE PARTS

623-37. A list of replaceable parts for the Alarm Set Point Output Option is given in Table 623-3. Refer to Section 5 of this

manual for ordering information.

CAUTION

Indicated devices are subject to damage by static discharge.

TABLE 623-3 LIST OF REPLACEABLE PARTS IS NOT AVAILABLE

Option -28
Current Transmitter Connectors

628-1. INTRODUCTION

628-2. The Current Transmitter Connectors are card-edge connector assemblies designed for use in making dc current measurements. The connector assemblies are compatible with the General Purpose Scanner (2200A-05) and Low Level Scanner (2200A-06) and are intended for use with the Model 2240C Data Logger, Model 2201A Scanner Chassis, Model 2202A Remote Chassis, and Model 2203A RTD Scanner Chassis. The connector assemblies mount on the rear of the data logger or scanner chassis and provide input connections in the form of screw terminals.

628-3. DESCRIPTION

628-4. Current Transmitter Inputs

628-5. The Current Transmitter Connectors provide accuracy and convenience in handling the output of current transmitters with dc current ranges of 1 to 15 mA, 4 to 20 mA, and 10 to 50 mA. The Current Transmitter Connectors accept the dc output current to a proportional dc voltage using precision shunt resistors. The dc voltage is then detected and displayed by the data logger. Up to 10 current transmitter inputs can be assigned to each Current Transmitter Connector.

628-6. With the exception of shunt resistor value, the Current Transmitter Connectors are identical in construction and operation. The 1 to 5 mA unit uses 60Ω shunt resistors, the 4 to 20 mA unit 15Ω shunt resistors, and the 10 to 50 mA unit 6Ω resistors. The Current Transmitter Connectors produce the same range of voltage readout on the data logger, i.e., 60 mV to 300 mV for 1 to 5 mA, 4 to 20 mA, and 10 to 50 mA current transmitter inputs.

628-7. General Purpose Current Inputs

628-8. The current handling capability of the Current Transmitter Connectors is not limited to 5 mA, 20 mA, and 50 mA. These values simply designate the appropriate connector for current transmitter use. For general lab or production applications, the current range for each connector is limited only by the maximum power dissipation in the associated shunt resistors. Since the shunt resistors are all 1/4 watt units, the maximum working dc current ranges are as follows:

Current Transmitter Connector	Maximum Current Input	Corresponding Full Scale Data Logger Readout
1 to 5 mA	0 to 64.5 mA	3.87V

4 to 20 mA	0 to 129 mA	1.935V
10 to 50 mA	0 to 204 mA	1.224V

628-9. Current Transmitter Readout Options

628-10. The basic Model 2240C Data Logger measures, records, and displays channel input data in terms of dc voltage. Depending on the range selected, the data is displayed in either millivolts or volts. Analog input signals, however, may represent any physical or electrical parameter such as pressure, temperature, flow, strain, voltage, current, etc. If proper signal conditioning and the appropriate scaling option are used, the data logger will measure, scale, and record data in the proper engineering units, e.g., oC, oF, psi, %, etc. Compatible transducers include thermocouples, thermistors, resistance temperature detectors (RTDs), or any device whose output is a dc voltage (1 uV to 40V) or dc current. Measuring, recording, and displaying data directly in terms or the transducer measurement unit requires one or more of the available scaling options.

628-11. Readout In Voltage

628-12. When the -28, -29, or -30 Current Transmitter Connectors are used in the basic data logger without adding any of the available Measurement and Scaling Options, the data logger will display and print out in dc volts and millivolts corresponding to current transmitter inputs.

628-13 Readout In Percent

628-14. Adding the -43 or -44 Temperature Option provides the data logger with the capability of scaling current transmitter inputs to provide reading in percent. For example, using the -28, -29 or -30 Current Trasmitter Connectors, a minimum (1 mA, 4 mA or 10 mA) current transmitter input would be displayed as 0% and a maximum (5 mA, 20 mA, 50 mA) input as 100%.The proper function and range for this application would be called by selecting the assigned front panel function.

628-15. Readout In Other Engineering Units

628-16. If the data logging application requires that current transmitter inputs be presented in measurement units other than percent, the data logger would have to be fitted with the 2240C-40 Scaling Option. The Custom Scaling Option provides the actual scaling necessary for readout in the desired measurement unit. Selections of units, provided by the mx+b Scaling Option, offers the customer's choice of notation, as shown in the Engineering Units Notation Table that follows:

Programmed Code	E/U	Programmed Code	E/U
01	ACA	17	DCV
02	ACmA	18	KV
03	DCA	19	mV
04	DCmA	20	uV
05	uA	21	ACW
06	dB	22	DCW
07	uF	23	KW
08	Hz	24	mW
09	KHz	25	uF
10	MHz	26	°C
11	psi	27	°F
12	S	28	
13	MS	29	K
14	uS	30	M
15	ACV	31	%
16	dBV	32	BLANK

628-17. For more information on custom scaling, refer to the scaling option (-40) section.

628-18. SPECIFICATIONS

628-19. See Table 628-1 for Current Transmitter Connector Specifications.

628-20. INPUT CONNECTIONS

628-21. Figure 628-1 shows the terminal assignments for the Current Transmitter Connectors. Access to the terminals is accomplished by removing the four screws from the decal side of the connector's input terminals which consist of HI, LO and Shield for each of the 10 channels. Best results are usually obtained using a 2-conductor shielded cable for each channel with the shield connected to the appropriate "SH" terminal at the connector and to source "LO" at the measurement source.

628-22. CONNECTION INSTALLATION

628-23. The Current Transmitter Connectors mount in any available scanner-block slot containing either a General Purpose or Lower Level Scanner. Install the connector as follows:

1. Unlatch the slide fasteners located on either side of the protruding enclosure at the rear of the data logger or scanner chassis as appropriate. Remove the enclosure from the rear panel.

2. Locate the desired scanner-block slot on the rear panel and check to ensure that a scanner is installed in the slot. See Figure 628-2 for scanner block arrangement in the 2240C data logger.

Table 628-1. Current Transmitter Connector Specifications

Type Connector: ..... Current Transmitter

Compatibility: ..... Mates with 2200A-05 and 2200A-06 scanners

Range	Current Transmitter	Maximum Input
Option 2240A-28:	1 to 5 mA dc	0 to 64.5 mA dc
Option 2240A-29:	4 to 20 mA dc	0 to 129 mA dc
Option 2240A-30:	10 to 50 mA dc	0 to 204 mA dc

Number of Inputs: 10

Number of Terminals: ..... 30 (HI, LO, and Shield) with a current shunt resistor connected between each HI and LO terminal.

Terminal Style: ..... Screw type

Shunt Resistances

Option 2240A-28: 60Ω
Option 2240A-29: 15Ω
Option 2240A-30: 6Ω

Maximum Input Power: (each input channel) 0.25W

Accuracy of Measurement: (20°C to 30°C) ..... Add **0.1% of reading** to all data logger accuracy specifications.

Temperature Coefficient: (0°C to 20°C, 30°C to 50°C) .....

High Performance A-D Converter
(0.0015% of reading +0.001% of range)/°C

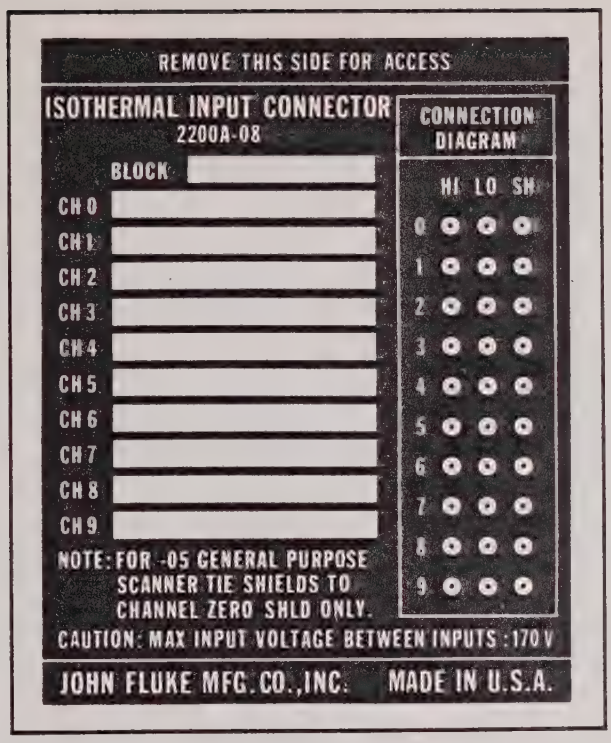


Figure 628-1.
Current Transmitter Connector Terminal Arrangement

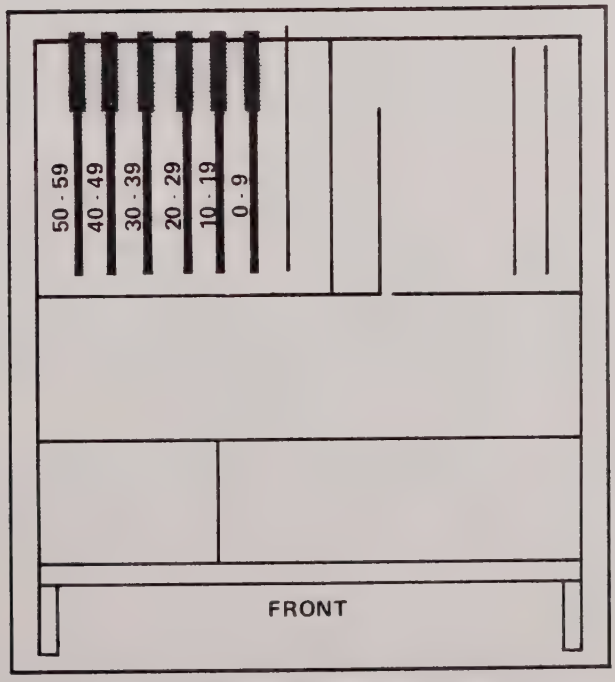


Figure 628-2.
Scanner Block Locations in the Model 2240C Data Logger

3. With the Current Transmitter Connector key positioned at the top, insert the connector in the scanner-block guides until it mates with the scanner connection.

4. Install the two retaining screws and washers that hold the connector to the data logger rear panel.

5. Repeat the procedure for additional connectors and install the rear-panel enclosures, routing the connector input cables out of the slot at the bottom of the enclosure.

628-24. OPERATION

628-25. To set up the data logger for current measurements using the Current Transmitter Connectors, proceed as follows:

1. Turn data logger power OFF.

2. Select the desired connector according to the required current range as follows:
   Option -28 1 to 5 mA (0 to 64.5 mA)
   Option -29 4 to 20 mA (0 to 129 mA)
   Option -30 10 to 50 mA (0 to 204 mA)

3. Connect current transmitters or other inputs to the connector.

4. Attach the wired Current Transmitter Connector to the desired scanner.

5. Turn data logger power ON.

6. Program the data logger for current transmitter or maximum range inputs, as shown in Table 628-2, for maximum resolution. Note that for current transmitter inputs, 100 mV of overrange capability is provided or 1.66 mA, 6.6 mA, and 16.6 mA at the input connector for 1 to 5 mA, 4 to 20 mA and 10 to 50 mA inputs, respectively.

7. Refer to Section 2 of the data logger manual for detailed instructions concerning programming of the data logger scan, display, and printout.

628-26. CALIBRATION

628-27. The shunt resistors in the Current Transmitter Connectors have been factory selected and do not require calibration. However, a calibration check is required after

Table 628-2. Data Logger Function and Range Programming for Current Transmitter Connectors

Current Transmitter Connector	Corresponding Voltage Output to Data Logger	Data Logger Function and Range Programming for Optimum Readout
For Current Transmitter Inputs		
Option —28 1 to 5 mA	60 to 300 mV	400 mV *
Option —29 4 to 20 mA	60 to 300 mV	400 mV *
Option —30 10 to 50 mA	60 to 300 mV	400 mV *
For Maximum Range Inputs		
Option —28 0 to 64.5 mA	0 to 3.87V	4V
Option —29 0 to 129 mA	0 to 1.935V	4V
Option —30 0 to 204 mA	0 to 1.224V	4V
* Or Current Transmitter input with -45 or -44 Temperature Options.		

repairs or any time it is desired to verify shunt resistor accuracy. The following procedure requires a digital multimeter capable of measuring resistance in true 4-terminal ohms configuration. Required specifications for the digital multimeter are given in Table 628-3.

1. Remove the cover from the Current Transmitter Connector.

2. Connect the digital multimeter OHMS SOURCE leads to CH0 HI and LO terminals as shown in Figure 628-3.

3. Connect the digital multimeter HI and LO OHMS SENSE leads to the terminals of resistor R6. Be sure the HI and LO OHMS SENSE leads are connected to the proper terminal of the resistor as shown in Figure 628-3.

4. Set digital multimeter controls for resistance measurements on the 200 Ohms range.

5. Verify digital multimeter readout as shown in Table 628-4.

6. Repeat steps (2) through (5) for channels CH1 through CH9 with OHMS SENSE leads connected to the corresponding shunt resistor for each channel, R7 through R15, respectively.

7. If the requirements of this test are not met, the associated shunt resistor, R6 through R15, should be replaced.

8. This includes the calibration check of the Current Transmitter Connector.

628-28. LIST OF REPLACEABLE PARTS

628-29. Tables 628-5 through 628-7 contain a list of replaceable parts for the Current Transmitter Connectors. For an explanation of column headings and ordering information, refer to Section 5 of the data logger manual.

Table 628-3. Required Test Equipment

Instrument Type	Minimum Use Specifications	Recommended Model
Digital Multimeter	Range: 0 to 60Ω Resolution: 1 mΩ Accuracy: ±0.01% Configuration: 4-Terminal Ohms	Fluke Model 8800A

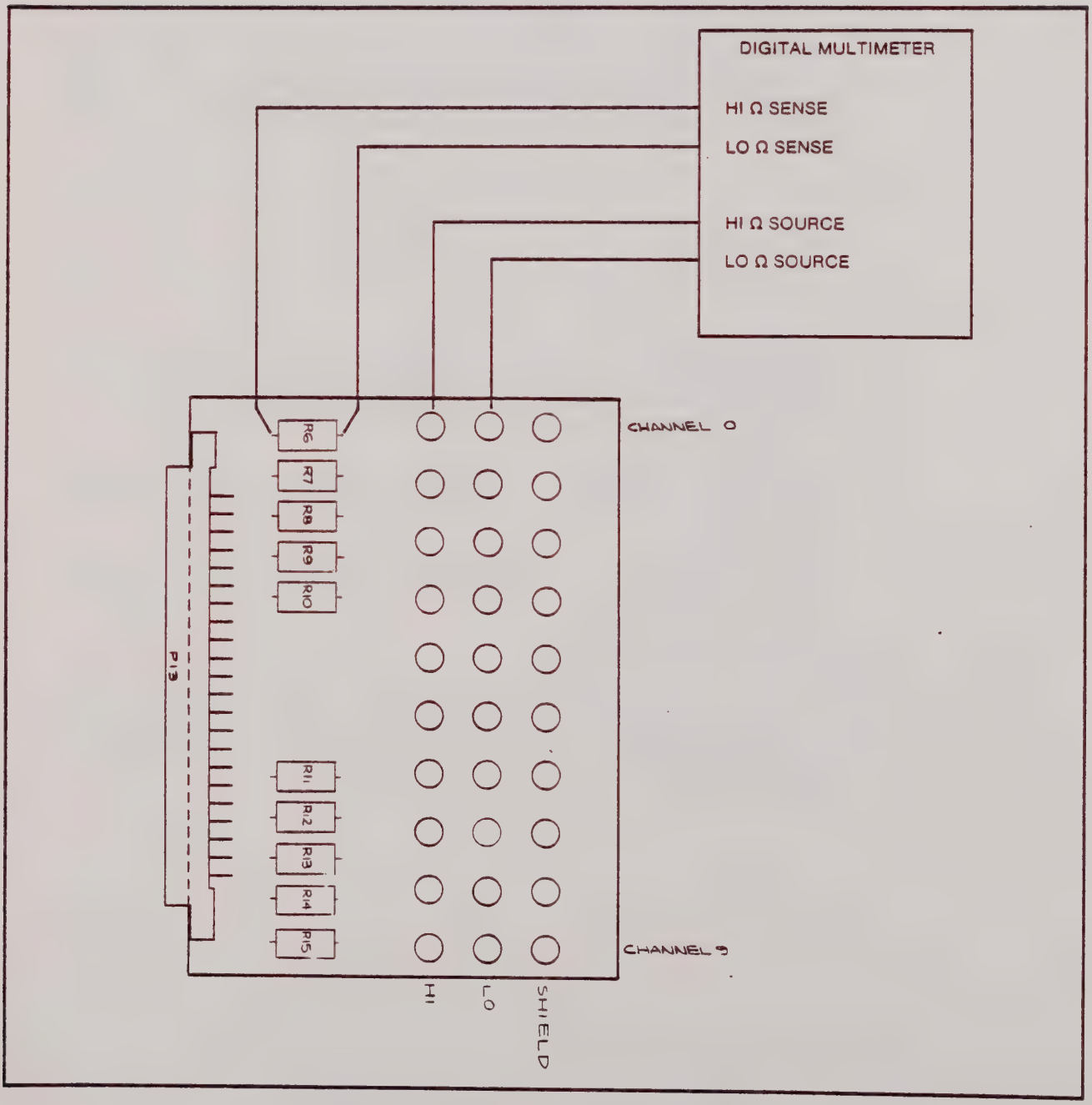


Figure 628-3. Equipment Connections for Shunt Resistor Accuracy Check

Table 628-4. Shunt Resistor Calibration Check

Current Transmitter Connector	Required DVM Readout Using 4-Terminal Ohms Measurement Connections
Option —28 1 to 5 mA	60.000Ω ±0.024Ω
Option —29 4 to 20 mA	15.000Ω ±0.006Ω
Option —30 10 to 50 mA	6.000Ω ±0.003Ω

TABLES 628-5 THRU 628-7 LISTS OF REPLACEABLE PARTS NOT AVAILABLE

Option -32
Dual Interval

632-1. INTRODUCTION

632-2. The Dual Interval, Option -32, is a factory installed software addition that provides the data logger with a second programmable scan control interval mode. This second interval can be controlled locally via the front panel keyboard or remotely if a Remote Programming Interface (Option -15 or -17) is installed. It has a range of 1 second, minimum, to 99 hours, 59 minutes, and 59 seconds, maximum. First and last channel assignments are independent of the standard scan format assignments.

632-3. As with the standard interval, the second interval can be enabled or disabled by programming its time. Setting a time of zero disables the interval, and setting a time other than zero enables the interval. When both intervals are enabled the standard interval has priority.

632-4. SPECIFICATIONS

632-5. Specifications for the Dual Interval Option are as follows:

INTERVAL TIME
Minimum: 1 second
Maximum: 99 hours, 59 minutes, and 59 seconds

CHANNEL LIMITS: None (000 to 999)

PROGRAM ENTRY: Manual (front panel) or remote (Option -15 or -17)

632-6. OPERATING NOTES

632-7. When the Dual Interval Option is installed, operation of the data logger is altered from that described in Section 2. These variations are discussed in the following paragraphs.

632-8. Program List

632-9. When a program list is manually solicited, the second interval time is printed after the standard program list is complete. This is followed by a list of first to last channels as assigned to the second interval. The channel format is the same as that of the standard scan.

632-10. When a program list is remotely solicited (via Remote Programming Interface) the second interval time, its first channel, and its last channel are listed after the standard program list format. This is followed by a list of first to last channels assigned to the second interval.

632-11. Program list can be printed on an external recorder or on the interval printer. Program Code P solicits a program list on an external printer. Code Q solicits a program list on the internal printer. See Remote Programming information (later in this subsection) or Option -15 or -17 documentation for additional details. Remember, set SCAN CONTROL to RESET and OUTPUT CONTROL to ALL DATA before attempting to solicit a program list.

632-12. Scan Control Modes

632-13. The effect of the second interval function on each of the scan modes is summarized in Table 632-1. Standard interval operation is not affected.

632-14. In the single and continuous scan modes the standard first and last channel assignments determine the channels to be scanned. In the continuous scan mode with the INTERVAL DATA print switch depressed, the second interval channels are not scanned unless a second interval time has been entered. If both interval programs simultaneously initiate print records, the standard interval data is recorded first and is followed by second interval data. If the standard interval time is less than the time necessary to record the standard interval data, the second interval will not be recorded.

632-15. In the monitor scan mode with the INTERVAL DATA print switch depressed both time intervals will cause a record of the monitor channel. The standard interval has priority when both intervals simultaneously trigger a record.

632-16. In the interval scan mode with either the INTERVAL DATA or the ALL DATA switch depressed, both time intervals will be recorded upon initiation of the scan. This occurs even if one of the interval times is set to zero. The interval that is set to zero will not trigger subsequent scans.

632-17. OPERATION

632-18. The Dual Interval can be programmed manually from the front panel keyboard or remotely though a Remote Programming Interface (Option -15 or -17). Instructions for both methods are given in the following paragraphs.

632-19. Keyboard Entry

632-20. Use the following procedure to enter second interval program data from the front panel keyboard:

1. Press the SECOND FUNCTION switch in the DATA ENTRY switch group. The display will show a series of "]" characters indicating the SECOND FUNCTION keypress.

2. Press the SECOND INTERVAL switch in the DATA ENTRY

Table 632-1. Scan Control vs Second Interval

SCAN CONTROL MODE	SECOND INTERVAL CHANNELS SCANNED AND DISPLAYED	OUTPUT RECORD TRIGGERED BY SECOND INTERVAL
Single	No	No
Interval	Yes	Yes
Monitor	No	Yes
Continuous	No	Yes

switch group. The display will show a series of t's (ttt tttttt).

3. Press the SECOND FUNCTION switch in the DATA ENTRY switch group.

4. Press the INTERVAL switch in the SCAN FORMAT switch group. The interval time in memory will be displayed, e.g., ttt 99.59 (99 hours, 59 minutes, seconds remain blank).

5. Enter the desired interval time on the DATA ENTRY keyboard and then press ENTER/STEP.

6. Press the SECOND INTERVAL switch followed by the FIRST CHANNEL switch. The display will read the first channel data in memory, e.g., 001 tttt.

7. Enter the desired first channel on the DATA ENTRY keyboard. When properly displayed, press ENTER/STEP.

8. Enter last channel data by pressing SECOND INTERVAL, LAST CHANNEL, LAST CHANNEL value on keyboard, and then ENTER/STEP.

632-21. **Remote Programming**

632-22. The Dual Interval function can be remotely programmed when the data logger is equipped with a Remote Programming Interface (Option -15 or -17) that has version 1 (or higher) software installed. Programming information for the Dual Interval Option is given in Table 632-2. If an error code of ERR07 is returned, the Dual Interval option is not installed. Error code, ERR03, indicates that Option -17 is equipped with version 0 software (i.e., not compatible with the Dual Interval Option). Refer to the Option -17 documentation for addtional programming details.

WARNING

The software version used on the Option -17 can be easily identified by the markings on its IC's in locations U1 and U2.

Table 632-2. Remote Programming

CODE	FORMAT	FUNCTION
G	Gaaa	Sets First Channel of Dual Interval to aaa (000 to 999).
K	Kaaa	Sets Last Channel of Dual Interval to aaa (000 to 999).
J	Jbb, cc	Sets Dual Interval time to bb hours (00 to 99) and cc minutes (00 to 59).
Q	Q	Program List on internal printer.

-33 Option
Eight Channel RTD Scanner

633-1. INTRODUCTION

633-2. The RTD Scanner (Option -33) is an eight-channel, two-wire relay scanner which operates in conjunction with the 2200 Series data logger and an RTD Input Connector (2200A-03) to provide excitation current and multiplex switching for up to eight RTD (resistance-temperature-device) inputs. The scanner can be installed in any one of the available scanner pcb slots in the data logger or an associated scanner chassis. Scanner input connections for the RTDS are acomplished using the 2200A-03 RTD Input Connector. When a channel is selected, reed relays in the scanner connect the RTD input to the data logger's Analog Bus. At the same time an on-board reference supply is energized to supply an adjustable excitation current (1 mA nominal) to the selected RTD. The resultant I-R drop is measured as a voltage and displayed in terms of temperature by the data logger.

633-3. SPECIFICATIONS

633-4. Specifications for the RTD Scanner are given in Table 633-1.

633-5. INSTALLATION

633-6. The Eight Channel RTD Scanner can be installed in any one of the scanner locations in a 2200B/2240C Data Logger. Use the following procedure to install a scanner:

WARNING

REMOVE LINE-POWER AND ALL OTHER HIGH VOLTAGE INPUTS TO THE DATA LOGGER BEFORE STARTING THIS PROCEDURE.

1. Remove the top cover and the inner top-guard cover from the data logger.

CAUTION

Handle the scanner pcb by its edges to avoid contaminating the pcb with oil from the hands. The use of gloves is recommended.

2. Select the location that includes the block of channels the scanner is to represent and align the scanner in the slot so that the large board-edge connector is toward the rear of the unit and the small offset board-edge connector is toward the

Table 633-1. RTD Scanner Specifications

RTD Channels..... 8

Ice-Point Resistance (standard)..... 100Ω ± 0.8%

Temperature Range..... −200°C to +775°C, −328°F to +1,427°F

Linearization Conformity.....0.035°C or 0.063°F

Resolution.....0.1°C or 0.1°F

Open RTD Indicates.....−245.0°C

System Accuracy.....NOTE: Specifications do not include sensor error.

TEMPERATURE RANGE	90-DAY 25 ± 5°C		1-YEAR 25 ± 10°C
	SLOW	FAST	SLOW
−200°C to −450°C	0.3°C	0.4°C	0.4°C
−450°C to −775°C	0.3°C	0.4°C	0.6°C
−328°F to +700°F	0.6°F	0.7°F	0.8°F
+700°F to +1427°F	0.6°F	0.8°F	1.0°F

Slow: 2.5 Rdgs/Sec
Fast: 15 Rdgs/Sec

NOTE:
Temperature Accuracy is based on the following RTD characteristics:

385 Platinum RTD
Alpha = 0.00385, delta = 1.52610, A4 = 0.759668E-4, C4 = 0.119619E-12

392 Platinum RTD
Alpha = 0.00392, delta = 1.49885, A4 = 0.59668E-13

10 Ohm Copper RTD
R0 = 9.042 Ohms
R25 = 10.005 Ohms
Alpha = 0.004260

bottom of the unit. Push the scanner straight down onto the mating connectors.

3. Prior to use, test and calibrate the scanner using the procedures given later under maintenance.

4. Install the inner guard cover and the top cover.

633-7. OPERATION

633-8. Once installed in the data logger the Eight Channel RTD Scanner requires no operator attention. However, certain considerations are necessary to properly interface the scanner with the RTDs. These considerations are discussed in the following paragraphs.

633-9. Input Connections

633-10. The 2200/2240 Series data loggers accept three types of input connectors depending on the type of scanner in use. The General Purpose and Low Level Scanners are compatible with both the -07 Solder Pin Connector and -08 Isothermal Connector. Refer to Option -07 and -08 subsections in Section 6 of the data logger manual for instructions covering hookup and installation of these connectors. The RTD Scanner is only compatible with the RTD Connector. Refer to Option -03 subsection in Section 6 of this manual for RTD Connector hookup and installation instructions. Refer to the following paragraphs for applications information concerning three- and four-terminal RTD measurements.

633-13. Input Pin Assignments

633-12. The pin assignments for the rear panel, card-edge connector of the RTD Scanner are shown in Figure 633-1. Since contact with signals on this connector is completed through the -03 RTD Connector, refer to the -03 Option subsection in this manual for pin assignments available for fabricating RTD interface cables.

633-13. Four-Terminal Measurements

633-14. Four-terminal RTDs must be connected to the scanner in true four-terminal configuration to achieve full accuracy from the system. Four-terminal RTDs are supplied by the manufacturer with four leads, usually two of one color and two of another. (Color code and other indentifying marks on RTDs vary with the manufacturer.) The two leads with a common connection at one end of the RTD should be connected to the HI and +S terminals of the RTD Connector and the remaining two leads should be connected to the LO and -S (sense terminals) of the RTD connections to channel 0 (CH0) and channel 1 (CH1) of the RTD Connector with the RTDs having four wires, two red and two white. Additional four-terminal RTDs would be connected in exactly the same manner to HI, LO, +S and -S terminals of any other available channels in

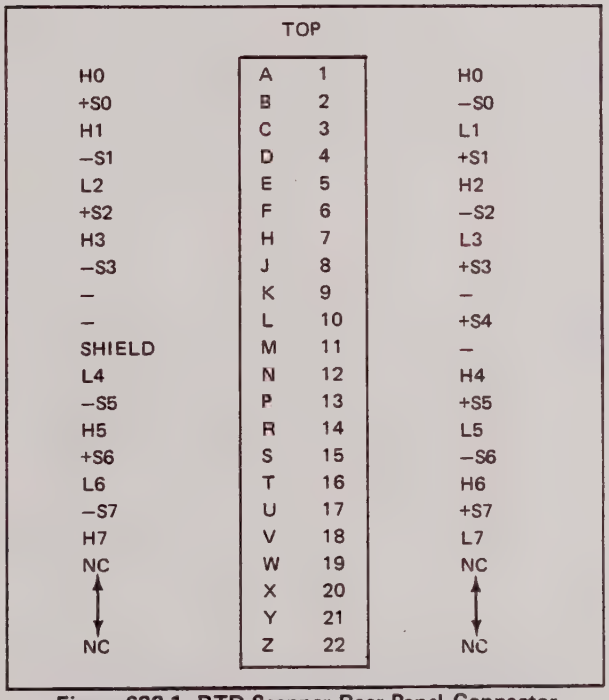


Figure 633-1. RTD Scanner Rear Panel Connector Pin Assignments

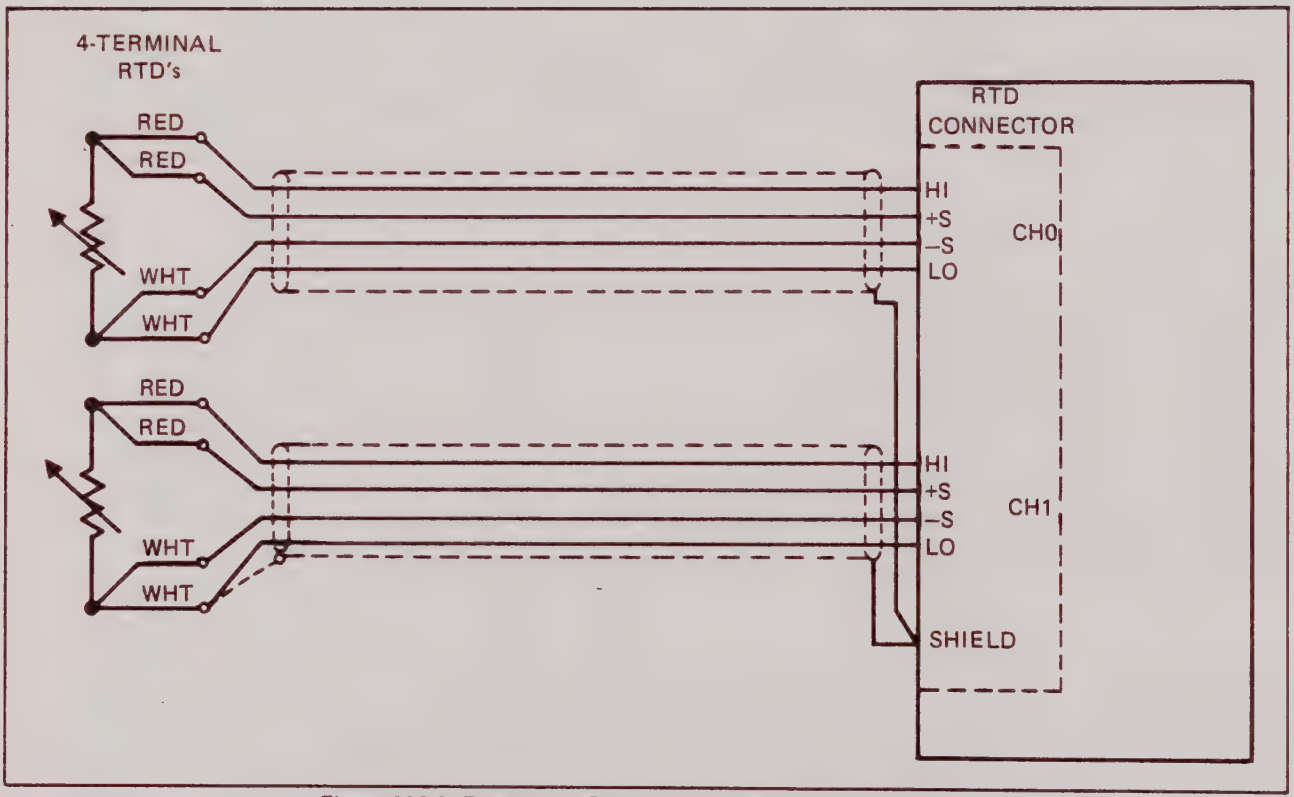


Figure 633-2. Example of Four-Terminal RTD Connections

the RTD Connector, up to a maximum of eight per scanner. When shielded input cables are used, best results are usually obtained by connecting all of the shields on the block to the common shield terminal. The best common mode rejection performance is usually obtained by connecting only one of these shields to the LO terminal at the RTD. When no shields are used, connect the shield input to the LO input of one of the channels.

633-15. It is important to note that four individual wires must be brought out from the scanner to connect to each four-terminal RTD, as shown in the diagram, to achieve true four-terminal RTD measurements. Connecting HI to +S and LO to -S at the scanner and extending two wires only for connection to the RTD will not provide a four-terminal measurement because sensing is not taking place at the RTD. Such a two-wire hookup actually comprises a two-terminal mesurement configuration, introducing associated lead resistance error into the measurement.

633-16. Three-Terminal Measurement

633-17. Three-terminal RTDs should be connected to the scanner as shown in Figure 633-3. In this hookup, the scanner LO and -S terminals are brought out to the RTD and connected to the common third wire on the RTD. The HI and +S terminals are connected individually to the remaining two RTD wires in the same manner as in the four-terminal hookup.

NOTE

Lead wire resistance errors are introduced by the resistance of the common or third wire of the RTD. For this reason the independent connection of -S and LO terminal should be made as close to the RTD sensing element as possible.

633-18. THEORY OF OPERATION

633-19. The RTD Scanner contains 11, form-A, double-pole, reed relays. A contact pair from eight of the relays, K0 through K7, is connected to two separate busses (one pole to each bus) to form a two-pole, eight-channel scanner complete with treeing relay, K10. The treeing relay operates when any one of the channel relays is operated. It is used to connect the scanner busses to the input of the data logger's A/D converter. Relay K11 operates in parallel with K10 to connect the scanner's shield to the data logger's guard. The remaining relay, K9, switches the output of the +10V reference supply onto the Analog Bus for measurement purposes. It is energized whenever channel 8 or 9 is selected on the scanner. A bcd-to-decimal decoder, U1, operates in conjunction with Q7 through Q15 to select the desired channel.

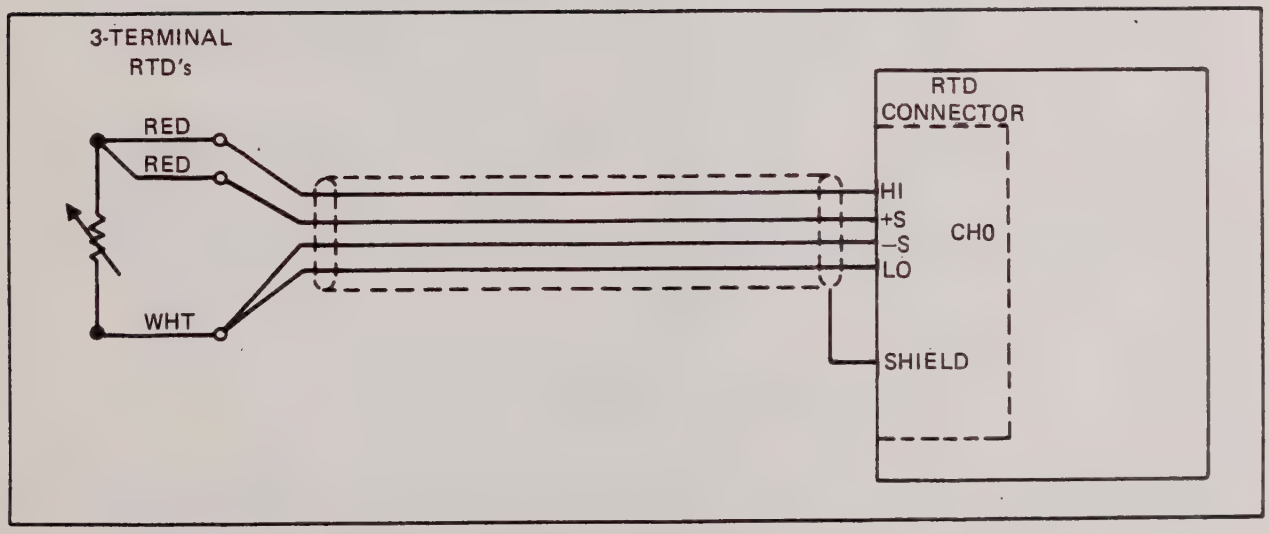


Figure 633-3. Example of Three-Terminal RTD Connections

633-20. Excitation current (1 mA) for the RTDs is supplied by an on-board 10 volt precision power supply. The supply is pwered by the guarded logic +5 volts supply (GL+5L) in the data logger. An inverter and a regulator on the scanner are used to generate the +10V dc output.

633-21. The power supply consists of a high frequency inverter (T1, Q1, Q2, CR1, CR2), a +15V dc regualtor (U2A, Q3, Q4, CR5) and a +10V dc regulator (U2B). The inverter is energized whenever a channel on the scanner is called. This provides the two regulators with isolated ac operating voltage by way of the transformer, T1, secondary winding. The voltage is rectified and filtered before being presented to the regulator as unregulated dc power. A conventional series-pass regulator is used to establish a stable supply for operating dual op amp U2. One half of U2 is used control the +15V dc regulator. The other half is used as a feedback amplifier to provide the +10V dc output. Both the +10 and +15V supplies use CR5 as a voltage reference.

633-22. The output of the +10V supply is applied through a precision wirewound resistor and potentiometer in each RTD input channel to the +S terminal (+Source). Three other input terminals, -S (-Source), HI, and LO operate with the +s terminal to provide true four-terminal ohms measurement capability. The potentiometer on each channel allows the RTD current to be adjusted for calibration purposes.

633-23. MAINTENANCE

633-24. Access Information

633-25. Refer to the installation information given in this option subsection for access information. Remove the rear panel input connector before attempting to remove the scanner pcb from the data logger.

633-26. Performance Test

633-27. The following performance test is designed to verify the overall operation of the Eight Channel RTD Scanner and is intended for use as an acceptance test and/or periodic maintenance check. The equipment used in the test is specified in Table 633-2. If the scanner fails any part of the test, corrective action is required.

1. Turn the data logger power off and disconnect the power cord from the ac line.

2. Install the Eight Channel RTD Scanner being tested in block 0 of the data logger.

3. Connect a 100 Ohm +0.1% resistor between the +S and -S terminals of each channel (0-7) on the RTD Input Connector (Option -03).

Table 633-2. Required Test Equipment

INSTRUMENT	RECOMMENDED MODEL
Data Logger	Fluke 2200B/2240C
Input Connector	Fluke Model 2200A-03
Resistors (8 each) (1)	100Ω ±0.1%, ¼ watt
Thermos Bottle (2)	1 pint for 0°C ice-point bath
RTD's (2)	RTD's that will be used with the –33 Scanner

(1) Used only in Performance Test
(2) Used only in Calibration Adjustments Procedure

4. Using a bare hookup wire, connect HI to +S and LO to -S on each channel of the RTD Input Connector.

5. Install the modified RTD Input Connector in block 0 of the data logger.

6. Connect the data logger to line power and set the power switch to POWER ON.

7. Program the data logger to read the voltage present at channel 9. Select the 40V range and observe the data logger display. The reading should be 10.000 +0.01.V dc. If the reading is incorrect, complete the power supply calibration adjustment (given later in this subsection) before proceeding.

8. Program the data logger to monitor the voltage at channel 0. The voltage should read approximately +100 mV dc.

9. Refer to Figure 633-4 and verify that the channel 0 potentiometer (R25) can be adjusted over a minimum range of 99.1 to 100.9 mV. Leave the adjustment set for a data logger reading of 100.00 mV.

10. Repeat steps 8 and 9 of this procedure for channel 1 through 7.

11. Program the data logger to scan and record the voltages at channels 0 through 7. Each reading chould indicate 100.00 ±0.02 mV.

12. Turn the data logger power off and disconnect the power cord from the ac line.

13. Disconnect the modified RTD Input Connector (block 0).

14. Remove the Eight Channel RTD Scanner from Block 0. This completes the performance test.

633-28. Calibration Adjustments

633-29. The Eight Channel RTD Scanner should be calibrated when it is initially installed in a data logger, and whenever the data logger is calibrated. Calibration adjustments for the scanner are shown in Figure 633-4. See Table 633-2 for the required test equipment. The procedure assumes that the data logger and the A/D Converter calibration procedures have been completed and that the scanner is installed in its assigned location.

633-30. +10 VOLT REFERENCE

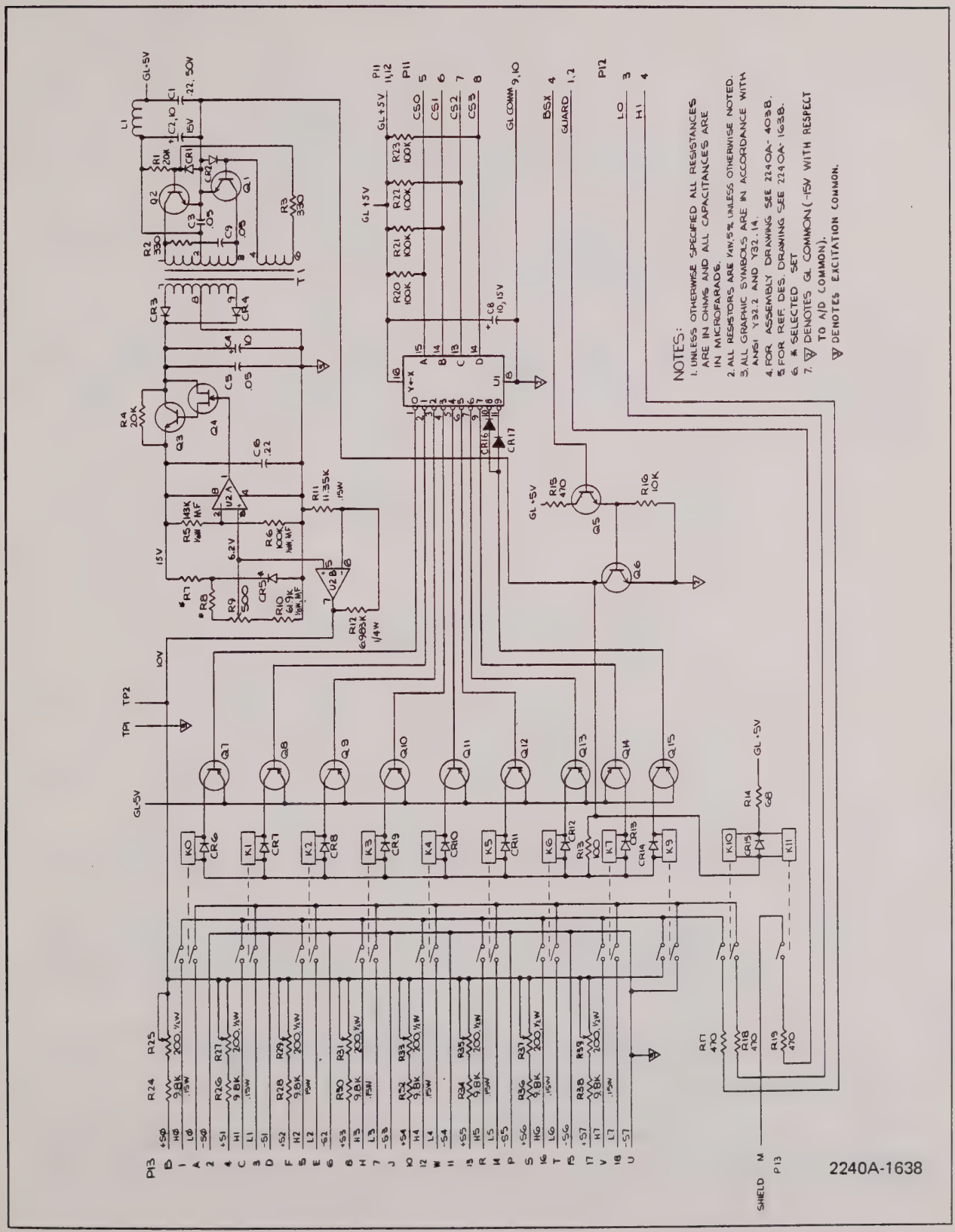

NOTES:
1. UNLESS OTHERWISE SPECIFIED ALL RESISTANCES ARE IN OHMS AND ALL CAPACITANCES ARE IN MICROFARADS.
2. ALL RESISTORS ARE ¼W, 5% UNLESS OTHERWISE NOTED.
3. ALL GRAPHIC SYMBOLS ARE IN ACCORDANCE WITH ANSI Y32.2 AND Y32.14.
4. FOR ASSEMBLY DRAWING SEE 2240A-4038.
5. FOR REF. DES. DRAWING SEE 2240A-1638.
6. * SELECTED SET
7. ▽ DENOTES GL COMMON (-15V WITH RESPECT TO A/D COMMON).
▽ DENOTES EXCITATION COMMON.
2240A-1638

Figure 633-4. Eight Channel RTD Scanner PCB Assembly

633-31. Use the following procedure to adjust the +10 volt reference supply:

1. Program the data logger to monitor the voltage on channel 9 of the scanner pcb being checked; use the 40V range. The voltage reading should be 10.000 ±0.010V dc.

2. If the reading is not within limits, adjust R9 on the scanner pcb for a reading of 10.000 ±0.002V dc. Disconnect the DMM.

633-33. Each RTD channel that is equipped with an RTD input must be calibrated when the RTD is connected. Calibration is accomplished by making screwdriver adjustments on the scanner pcb. These adjustments set the RTD excitation current so that a known I-R (voltage) is produced across the RTD at a known temperature (0oC).

1. Determine the location of the scanner to be calibrated and attach its RTDs using the RTD Input Connector.

NOTE

RTDs are assumed to have a resistance 100 Ohms ±0.8% at 0°C.

2. Remove the top cover and the inner guard cover from the data logger.

3. Prepare a 0°C (32°F) ice-point bath using 1 pint thermos bottle.

4. Place each RTD to be calibrated in the ice-point bath and allow the RTD temperature to stabilize.

5. Monitor each scanner channel and adjust the appropriate potentiometer (see Figure 633-4) for a reading of 00.0 °C (32.0°F) on the RTD measurement function or 100.00 on the 400 mV range.

6. Install the top and inner guard covers after the calibration adjustments have been completed.

633-35. LIST OF REPLACEABLE PARTS

633-35. A list of replaceable parts for the Eight Channel RTD Scanner is given in Table 633-3. Refer to Section 5 of this manual for ordering information.

TABLE 633-3 LIST OF REPLACEABLE PARTS NOT AVAILABLE

Option -40
mx + b Scaling Option

640-1. INTRODUCTION

640-2. The mx + b Scaling Option (Option -40) provides 30 user-programmable scaling functions and Engineering Units notation for the 2240C. Scaling functions and Engineering Units notation are programmable from the 2240C front panel. It requires factory or Fluke Service Center installation.

640-3. Any of the 30 user-selected scaling functions may be assigned to any channel, or any group of channels within the 2240C system, and a single scaling function may be assigned to more than one channel or group of channels. In addition, decimal point location within the displayed information is programmable, allowing a scaled presentation on the 2240C data display. Engineering units notation is not displayed on the 2240C data display, or on an external recording device, but can be programmed to appear on the printer output.

640-4. SPECIFICATIONS

640-5. Specifications for the Scaling Option are as follows:

Scaling Functions.....30 (30 m and 30 b values)
Engineering Units.....32 (see Table 640-1.)
Decimal Positions.....5 (Maximum)

Ranges

Slope (m).....-9.9999 to +9.9999
Intercept.....-99999 to +999999

In addition, the Scaling Option meets all environmental specifications of the 2240C.

640-6. OPERATING NOTES

640-7. Programming the mx + b Scaling Option is accomplished through 2240C front panel controls. Limits can be set for use with the Scaling function, and any limits established apply to the scaled data, not the original input data.

640-8. mx + b General Equation

640-9. The Scaling expression, mx+b, allows output conditioning to reflect specific user requirements. It defines the data indication on the display. The complete equation is Y = mx+b, where Y is the displayed data. The element m in the equation is referred to as the slope of the scaling function; the element b is the intercept value; the element x is the input data.

640-10. A general set of equations, represented by Figure 640-1,

Table 640-1. Engineering Units Codes.

CODE	NOTATION	CODE	NOTATION
01	ACA	17	DCV
02	ACmA	18	KV
03	DCA	19	mV
04	DCmA	20	uV
05	uA	21	ACW
06	dB	22	DCW
07	uF	23	KW
08	Hz	24	mW
09	KHz	25	uW
10	MHz	26	C
11	psi	27	F
12	S	28	
13	ms	29	K
14	us	30	M
15	ACV	31	%
16	dBV	32	BLANK

FIGURE 640-1 NOT AVAILABLE

for determining slope and intercept is:

$$\text{Slope} = m = \frac{\text{Display Hi} - \text{Display Lo}}{\text{Input Hi} - \text{Input Lo}}$$

$$\text{Intercept} = b = \text{Display Lo} - (m \times \text{Input Lo})$$

640-11. All values in these equations are in terms of A/D converter counts (as seen on the display, ignoring the decimal point). The display is limited to five digits.

640-12. mx+b Programming Example

640-13. Assume that input data is being received from a 100 to 200 psi pressure transducer with a 4-20 mA output. The data logger, when properly configured with a Current Transmitter Connector (Option -29), receives a 60mV to 300mV signal from the connector option. In A/D Converter counts, 60mV equals 6000 and 300mV equals 30,000 counts. The desired display is chosen as 200.00->100.00 psi. In terms of A/D counts, this is 20,000 and 10,000 counts, respectively.

640-14. To obtain the desired indication on the disply, the input data must be scaled. Applying the general formula for slope, the required slope value is:

$$\text{Slope} = \frac{20{,}000-10{,}000}{30{,}000-6{,}000} = 0.4167 = m$$

The required value is:

$$\text{Intercept} = 10{,}000-(0.4167 \times 6{,}000) = 7500 = b$$

The slope intercept values used in this example are illustrated in Figure 640-2.

640-15. OPERATING INSTRUCTIONS

640-16. Two procedures are necessary to operate the Scaling Option. First, the desired slope and intercept values must be established for one of the 30 possible scaling addresses. Then that scaling address and A/D Converter range must be selected and assigned to the channel or channels with which it is to be used. The first procedure outlines establishing the desired slope and intercept values for a particular scaling function. The second procedure outlines programming that scaling function for use with a specific channel.

A. Assign values to an mx+b address.

1. Press the SECOND FUNCTION button located in the DATA ENTRY section of the front panel, then press the ENTER ADDRESS button in the LIMITS/mx+b

FIGURE 640-2 NOT AVAILABLE

programming section.

2. Press on or two digits (1-30) in the DATA ENTRY front panel section to select a mx+b address, then press the ENTER/STEP button. Example: press 5, then ENTER/STEP to assign an address number of 5 to the scaling function. After pressing ENTER/STEP, both the SENSE/mx+b light and the HI/m light will be on, indicating that the slope value (m) should be entered next.

3. To enter the slope value, press the appropriate digits in the DATA ENTRY group, then press the ENTER/STEP button. Example: press 0, 4, 1, 6, 7, then ENTER/STEP to enter a slope of 0.4167. After pressing ENTER/STEP, both the SENSE/mx+b light and the LO/b light will be on, indicating that an intercept value (b) should be entered next.

4. To enter an intercept value, press the appropriate digit switches in the front panel DATA ENTRY group, then press ENTER/STEP. Example: press 7, 5, 0, 0, and ENTER/STEP is pressed, the both the Hi/m and LO/b lights will be on, indicating a decimal point location may be entered next.

5. To enter a decmial point position, press the digit in the DATA ENTRY group represents the number of digits to the right of the decimal point, then press ENTER/STEP. Example: press 2 then ENTER/STEP. In this case, the DISPLAY should read 75.00 to indicate our offset of 75 psi. After ENTER/STEP is pressed, the UNITS lamp will be on, indicating tht engineering units notation may be programmed next.

6. To program engineering units notatin, enter the appropriate 2-digit code (refer to Table 640-1) for the unit desired, then press the ENTER/STEP button. Example: press 1, 1, and ENTER/STEP. Engineering Units notation psi is programmed to appear on the printer.

B. Assign a scaling function to a channel.

1. Press the ENTER ADDRESS button in the CHANNEL programming group.

2. Press the appropriate digits in the DATA ENTRY front panel section to select the channel address. Example: Press 2, then 5 to select channel 25.

3. Press the ENTER/STEP button in the DATA ENTRY front panel section to enter the channel address. After the ENTER/STEP button is pressed, the ENTER

FUNCTION light in the CHANNEL section of the front panel will light.

4. Press the desired button in the DATA ENTRY sectoin of the front panel, then the ENTER/STEP button, to enter an A/D converter range. Example: to enter a 400 mV range, press 400 mV, then ENTER/STEP. After the ENTER/STEP switch is pressed, the ENTER mx+b ADDRESS light in the CHANNEL section will light.

5. Press the required digits in the DATA ENTRY front panel section necessary to enter the appropriate scaling function. Example: To enter scaling function address number 5, press 5, then ENTER/STEP. After ENTER/STEP is pressed, the ENTER LIMIT ADDRESS light in the CHANNEL section of the front panel will light, and the LIMIT A light just to the right of the DATA display will light.

6. To enter a limit address, press the appropriate digits in the DATA ENTRY front panel section, then press the ENTER/STEP button. If limits are not needed, press the SKOP button, then the ENTER/STEP button.

NOTE

The ENTER LIMIT ADDRESS light will remain illuminated to indicate that limits, B, C, and D can be entered at this time. Repeat step 6 for each limit.

7. Select SCAN CONTROL and OUTPUT CONTROL functions from the front panel OPERATOR section (Refer to Section 2 of the 2240C Instruction Manual).

640-17. THEORY OF OPERATION

640-18. Introduction

640-19. Option -40, the Scaling Option, consists of one PROM (Programmable Read Only Memory) and four RAMs (Random Access Memory). The PROM is located on the Controller pcb and is designated U7. The RAMs are located on the Range and Function Memory pcb, and are designated U8, U9, U16, and U17.

640-20. Function

640-21. The PROM located on the Controller pcb is a configuration PROM which contains engineering units notation programming. It is structured such that PROM locations correspond to the two-digit code entered for a specific engineering units notation. The four RAMs on the Range and Function Memory pcb

provide memory storage for the 30 user-programmable scaling functions. Refer to Section 3 of the 2240C mainframe manual for additional information.

640-22. MAINTENANCE

640-23. Option -40 does not require periodic maintenance or calibration. Troubleshooting information is given in Section 4 of the mainframe manual.

Table 640-1. Engineering Units Codes.

CODE	NOTATION	CODE	NOTATION
01	ACA	17	DCV
02	ACmA	18	KV
03	DCA	19	mV
04	DCmA	20	uV
05	uA	21	ACW
06	dB	22	DCW
07	uF	23	KW
08	Hz	24	mW
09	KHz	25	uW
10	MHz	26	C
11	psi	27	F
12	S	28	
13	ms	29	K
14	us	30	M
15	ACV	31	%
16	dBV	32	BLANK

Option 41
Alarm Setpoint Option

641.1 INTRODUCTION

641-2. The Alarm Setpoint Option Option (Option -41) is a factory or service center installed set of ICs that provide four limits per channel in the 2240C, with maximum of 60 individual limit set points. Limits are divided into 4 distinct groups of 15 limits. Limits group A consists of limit addresses 1 through 15; group B consists of addresses 16 through 30; group C consists of addresses 31 through 45; group D consists of addresses 46 through 60. One limit from each group may be assigned to each channel, which provides a maximum of four limits per channel. Limit values are assigned through the front panel DATA ENTRY keyboard, and each of the 60 limits may be addressed by entering a two-digit limit address through the 2240C front panel controls.

641-3. All limits within a group may be set as either a high or low limit or any combination of highs and lows. Limits may be applied to either a group avaerage or time average if the Averaging Option (Option -42) is in use. Limit values are pur numbers, and as such, assume the same engineering nmotation and decimal point position as the data from the channel to which they are assigned.

641-4. In addition, one programmed limit value may be applied to any number of channels. For instance, if limit numer 5 were initially assigned a value of 20, and all 1000 possible channels needed a low limit of 20, limit number 5 could be assigned to every channel in the system as a low limit. The remaining 59 limit values could be used for other limit requirements or left unassigned.

641-5. SPECIFICATIONS

641-6. Specifications for the Alarm Setpoint Option are given in Table 641-1.

641-7. OPERATION

641-8. Operating procedures for the Alarm Setpoint Option (-41) consist of assigning a value to the various limits address to be used, then assigning those limits address to the applicable channels in the 2240C. The following procedures may be used to assign a value to a limit address and assign a limit address to a channel.

A. Assign a value to a limit address.

1. Press the ENTER ADDRESS button in the LIMITS/mx+b front panel section.

2. Press on or two digits (1-60) in the DATA

TABLE 641-1 NOT AVAILABLE

ENTRY front panel section to select a limits address, then press ENTER/STEP. After ENTER/STEP is pressed, the SENSE lamp and either the HI or LO lamp in the LIMITS/mx+b section will light.

3. If the limit being programmed is already the proper sense (HI limit or LO limit), press ENTER/STEP and proceed to step 4. To establish a liit as HI or LOW, press either HI or LO button in the DATA ENTRY front panel section, followed by the ENTER/STEP button. After ENTER/STEP is pressed, the VALUE lamp in the LIMITS/mx+b section will light to indicatea value must by entered.

4. To enter a limit value, press the appropriate digits in the DATA ENTRY section, followed by the ENTER/STEP button. Upon pressing the ENTER/STEP button, the ENTER ADDRESS light in the LIMIT/mx+b front panel section will light. The next limit address can be programmed at this time. Repeat steps 1 through 4 program the next limit address.

B. Assign a limit address to a channel.

1. In the channel programming group, press ENTER ADDRESS.

2. Press the required digits in the DATA ENTRY group to select a channel address, then press the ENTRY/STEP button.

3. The ENTER FUNCTION lamp will light in the CHANNEL group after the ENTER/STEP button is pressed. Enter the channel function (see Section 2 of the 2240C Manual) then press the ENTER/STEP button.

4. Next, the ENTER ADDRESS mx+b lamp in the CHANNEL section will light. Enter a scaling address or press SKIP if no scaling is required, then press the ENTER/STEP button.

5. The ENTER ADDRESS LIMIT (A, B, C, D) lamp in the CHANNEL section will light upon completion of the mx+b programming, along with the lamp marked A, located just to the right of the DATA display.

6. Press the DATA ENTRY group digits required to enter a limits address from limits group A (1-15) then press the ENTER/STEP button.

Example: to assign limit address number 5 to the selected channel, press 0, 5, and ENTER/STEP.

7. Upon pressing ENTER/STEP, the lamp marked B, just to the right of the DATA display, will light. Either enter an address from limit from group B (16-30) or press SKIP is no limit from group B is required for that specific channel.

8. Repeat the preceeding procedure for limits group C and D.

9. Repeat steps 1 through 8 for each additional channel to which a limit must be assigned.

641-9. THEORY OF OPERATION

641-10. Option -41, the Limit Option consists of six RAM chips installed on the Range and Function Memory pcb. These chips provide memory for the limits functions. Refer to Section 3 of the mainframe manual for additional information.

641-11. MAINTENANCE

641-12. The Limits Option (Option 41) does not require periodic maintenance or calibration. Troubleshooting information is given in Section 4 of the 2240C mainframe manual.

Option -42
Data Averaging Option

642-1. The Data Averaging Option (Option -42) provides data averaging in either of two modes: time averaging or group averaging. In the time averaging mode, up to 30 channels may be individually averaged over a user-selectable time interval, with a user-selectable averaging window of from 1 to 99 scans. In the group average mode, channel group may include from 2 to 99 channels, as determined by the operator.

642-3. SPECIFICATIONS

642-4. Specifications for the Data Averaging Option (Option -42) are given in Table 642-1. In addition, the Data Averaging Option meets all environmental specifications given for the 2240C mainframe (see Section 1 of the mainframe manual).

642-5. INSTALLATION AND OPERATION

642-6. Option -42 requires factory or Fluke Service Center installation.

642-7. Operating procedures for group averaging and time averaging are slightly differenty from each other. The following procedures detail both time averaging and group averaging programming through the 2240C front panel buttons. Channels selected for time averaging or group averaging must be consecutively numbered, but any channel or channels within the group may be excluded using the SKIP button on the front panel. Channels that are programmed for SKIP will not be included in the averaging calculation.

A. TIME AVERAGING PROGRAMMING

1. Press the SECOND FUNCTION button in the DATA ENTRY section of the front panel.

2. press the TIME AVERAGE button, also located in the DATA ENTRY front panel section, to establish the time averaging mode of operation.

3. Press the appropriate digit buttons in the DATA ENTRY keyboard to establish the number of scans per average, then press the ENTER/STEP button. Example: to average readings over a 20-scan period, press 2, 0, then ENTER/STEP.

4. Press the SECOND FUNCTION and TIME AVERAGE button again, followed by the FIRST CHANNEL button in the SCAN FORMAT front panel section.

5. Press the digit buttons required to establish

TABLE 642-1 NOT AVAILABLE

the first channel to e averaged, then press ENTER/STEP.

6. Press SECOND FUNCTION and TIME AVERAGE again, followed by the LAST CHANNEL button in the SCAN FORMAT front panel section, then press the digit buttons necessary to establish the last channel. Press ENTER/STEP.

7. To establish a Time Average scan interval, press the SECOND FUNCTION button, then the INTERVAL/HR MIN SEC button. Press the digit buttons required to establish a scan interval, then press ENTER/STEP.

B. GROUP AVERAGING PROGRAMMING

1. Press the SECOND FUNCTION button, then the GROUP AVERAGE button, both located in the DATA ENTRY front panel section.

2. Press the necessary digit buttons in the DATA ENTRY section of the front panel to establish a group size, then press ENTER/STEP. Example: press 5, then ENTER/STEP to establish a group size of 5 channels.

3. Press the SECOND FUNCTION and GROUP AVERAGE buttons again, then press the FIRST CHANNEL button. Press the digit button (s) required to establish the first channel for group averaging, then press the ENTER/STEP button.

4. Press the SECOND FUNCTION button once again, then the LAST CHANNEL button. Press the required digit buttons to establish a last channel for group averaging, then press the ENTER/STEP button.

5. To establish a group average scan interval, press the SECOND FUNCTION button, then the GROUP AVERAGE button, then the INTERVAL/HR MIN SEC button. Press the digit buttons required to set the desired scan interval, then press the ENTER/STEP button. Example: press SECOND FUNCTION, INTERVAL/HR MIN SEC, 1, 0, 0, and ENTER/STEP to establish a second scan at one minute intervals.

642-8. THEORY OF OPERATION

642-9. Four RAM ICs installed on the Controller pcb and two RAM ICs installed on the Keyboard Memory pcb comprise the Data Averaging Option. Data Averaging Option RAMs on the Controller

pcb are U23, U24, U25, and U26. Data Averaging Options RAMs on the Keyboard Memory pcb are U4 and U5.

642-10. The RAM ICs installed on the Controller pcb are used for averaging calculations. Those mounted on the keyboard memory pcb provide memory locations for first and last channel numbers and the averaging interval. The Keyboard Memory pcb RAMs are nonvolatile.

642-11. MAINTENANCE

642-12. The Data Averaging Option does not require periodic maintenance or calibration. Troubleshooting procedures for the Data Averaging Option are included in the mainframe troubleshooting chart, located in Section 4.

Options -43 and -44
Temperature

643-1. INTRODUCTION

643-2. Temperature Scaling options (Option 43 or 44) are factory installed options that provide temperature measurement and linearization capability for the data logger. Measurement readings using 12 different linearizations are available with either option, along with a current transmitter reading, displayed as a percent of scale. Option 43 and Option 44 contain linearization programs for different types of input transducers, but they are otherwise identical.

643-3. When using thermocouple inputs, the Temperature Option operates in conjunction with the isothermal connectors to provide direct temperature readouts selectable in °C or °F, with 0.1° resolution. Linearization and scaling programs can be chosen for a total of twelve thermocouple types. These twelve can be any combination of the available thermocouple types shown in Table 643-1.

643-4. Current measurements derived from any of 3 types of current transmitter connectors can be scaled by the Temperature Option to provide readings in percent. For example, the 1 to 5 mA current transmitter input would be scaled to read 1 mA as 0% and 5 mA at 100%. If measurement units other than percent are required, the mx+b Scaling Option (Option -40) must be installed.

643-5. SPECIFICATIONS

643-6. Specifications for the Temperature Option are contained in Section 1 of this manual.

643-7. OPERATION

643-8. Once installed in the data logger, the Temperature Option requires no operator attention other than ensuring that the transducers connected at the measurement channels are compatible with the measurement functions selected for those channels. Instructions for assigning measurement functions to specific channels are contained in Section 2 of this manual.

643-9. The temperature measurement scale can be set by the user to provide a direct temperature readout in either °C or °F. A switch located on the controller is used to select the desired scale. Information necessary to properly set the switch is given later under maintenance.

NOTE

Thermocouple temperature measurements require the use of an Isothermal Block Connector

TABLE 643-1. Thermocouple Linearizations, Option 43 and 44.

OPTION	THERMOCOUPLES
43	J, K, T, S, R, B, E, C, 385, 390, 10 Cu ,0-100%, Ref Junct.
44	J, K, T, S, Jdin, Kdin, Tdin, Sdin, N*, 385, 392, 0-100%, Reference Junction.

*Nicrosil

(Option -08).

NOTE

When a series of C's is displayed during a scan sequence, it indicates that the thermocouple input for the channel indicated is open circuited (R source >7.5 ±2.5 K Ohms).

643-10. THEORY OF OPERATION

643-11. General

643-12. The Temperature and Scaling Option operates as an extension of the A/D Converter to provide direct-reading temperature measurements using thermocouuple or RTD probes. It consists of a Temperature Measurement PCB and two linearization ROMs. The Temperature Measurement PCB mounts on the a/d converter as a plug-in subassembly and provides the analog switching necessary for open thermocouple detection as well as reference junction measurement. Both ROMs plug into sockets provided on the Controller PCB. The linearization ROMs contain the linearization program for the microprocessor and the linearization tables for the selected thermocouple types. Table 643-1 lists the appropriate thermocouple types for each option (-43 and -44).

643-13. When a temperature measurement is made, the processor first calls for a reference junction measurement to determine the temperature of the terminal block on the measurement channel's Isothermal Block Connector (Option -08). Since this temperature is the same for all thermocouples associated with the block connector, only one measurement is required each time the block channels are scanned. Measured reference junction data is then sent to the microprocessor where it is used to derive a voltage offset which is the difference between the voltage generated at the thermocouple termination at ambient temperature and the terminal voltage which would be observed at 0°C. (The difference is due to the thermocouple effect at the terminal block where a transition is made from thermocouple wire alloys to copper.) This voltage is then added to each subsequently measured thermocouple voltage at the Isothermal Block Connector. The result is a thermocouple output relative to a terminal point temperature of 0°C. Finally the corrected thermocouple voltage is converted, via a piecewise linear approximation (linearization ROM), into an equivalent temperature which is subsequently displayed.

643-14. Temperature Measurement PCB Assembly

643-15. The operation of the Temperature Measurement PCB can be divided into three separate functions: open thermocouple detector, reference voltage buffer, and reference juction

measurement. Refer to the schematic diagram, Figure 643-2, to supplement the following descriptions.

643-16. Open thermocouple detection is enabled when the measurement function has been programmed for a thermocouple temperature measurement. The enabling program data bit is stored in the function register on the A/D Converter PCB and is delivered to the Temperature Measurement PCB as a low signal via the T (temperature) input. At the end of the a/d converter's integration period (during delta 2), relay K2 is energized and R-S flip-flop (U1B and U1C) is preset. The closed contacts of K2 allow the flip-flop to observe the condition of the input thermocouple, and reset if a normally low impedance is encountered (<7.5 ±2.5 k ohms). Otherwise the flip-flop will remain in the preset condition and generate an open-thermocouple indication (open TC low). At the beginning of the read portion of the measurement cycle the delta 2 pulse returns low allowing relay K2 to open. This allows the flip-flop to remain latched in its current position until changed during subsequent temperature measurement cycles.

643-17. The reference voltage used to power the reference junction circuitry on the Isothermal Block Connectors (Option -08) is derived from the 6.2V reference on the A/D Converter PCB. A unity gain amplifier on the Temperature Measurement PCB buffers the reference voltage and drives the 6.2V Bus which supplies operating power to the Isothermal Connectors housed in both the data logger and the extender chassis.

643-18. When the reference junction is to be measured, input RJ (from the function register on the a/d converter) is driven low causing the DPST contacts of relay K1 to close. As a result, the output of the reference voltage amplifier is connected to the 6.2V Reference Bus. A return signal in the form of reference junction temperature from the enabled Isothermal Block Connector (Option -08) is presented to the a/d converter for measurement purposes through the other pair of relay contacts.

643-19. MAINTENANCE

643-20. Access

643-21. The Temperature and Scaling Option comprises one pcb assembly and two IC's. These components are installed on two separate locations in the data logger and can be easily accessed for maintenance purposes. Figure 643-1 defines the individual component locations of both the controller and A/D Converter PCB's. Access to these pcb's is achieved by removing the top cover and the two inner guard covers from the data logger.

643-22. Temperature Scale Switch Settings

643-23. Temperature measurements can be displayed in terms of either ^{o}C or ^{o}F by properly setting a switch on the Controller

FIGURES 643-1 and -2 NOT AVAILABLE

PCB Assembly. The switch location is shown in Figure 643-2 (Celsius/Fahrenheit switch, #3). Setting the switch to ON selects the Fahrenheit scale. Conversely, OFF selects the Celsius scale.

643-24. Calibration

643-25. The Temperature Option does not require calibration. However, its accuracy is dependent upon the calibration of the A/D Converter and the reference junction on the Isothermal Block Connector (Option -08).

643-26. LIST OF REPLACEABLE PARTS

643-27. A list of replaceable parts for the Temperature Option is given in Table 643-2. Refer to Section 5 of this manual for ordering information.

CAUTION

Indicated devices are subject to damage by static discharge.

TABLE 643-2 LIST OF REPLACEABLE PARTS NOT AVAILABLE

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